TEXAS AGRICULTURAL EXPERIMENT STATION

A. B. CONNER, DIRECTOR

COLLEGE STATION, BRAZOS COUNTY, TEXAS

FORTY-FIRST ANNUAL REPORT
1928

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS

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V. L. Cory, M. S., *Grazing Research Botanist*
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**J. N. Tate, B. S., *Assistant; Ranch Records and Accounts*

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Sidney D. Reynolds, Jr., *Feed Inspector*
P. A. Moore, *Feed Inspector*

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P. R. Johnson, M. S., *Act. Superintendent*

No. 3, Angleton, Brazoria County:
R. H. Stansel, M. S., *Superintendent*

No. 4, Beaumont, Jefferson County:
R. H. Wyche, B. S., *Superintendent*

No. 5, Temple, Bell County:
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B. F. Dana, M. S., *Plant Pathologist*
H. E. Rea, B. S., *Agronomist; Cotton Root Rot Investigations*
Simon E. Wolff, M. S., *Botanist; Cotton Root Rot Investigations*

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No. 8, Lubbock, Lubbock County:
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Frank Gaines, *Irrigationist and Forest Nurseryman*

No. 9, Balmorhea, Reeves County:
J. J. Bayles, B. S., *Superintendent*

No. 10, Feeding and Breeding Station, near College Station, Brazos County:
R. M. Sherwood, M. S., *Animal Husbandman in Charge of Farm*
L. J. McCall, *Farm Superintendent*

No. 11, Nacogdoches, Nacogdoches County:
H. F. Morris, M. S., *Superintendent*

No. 12, Chillicothe, Hardeman County:
**J. R. Quinby, B. S., *Superintendent*
**J. C. Stephens, M. A., *Assistant Agronomist*

No. 14, Sonora, Sutton-Edwards Counties:
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V. L. Cory, M. S., *Grazing Research Botanist*
**O. G. Babcock, B. S., *Collaborating Entomologist*
O. L. Carpenter, *Shepherd*

No. 15, Weslaco, Hidalgo County:
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Sherman W. Clark, B. S., *Entomologist*
W. J. Bach, M. S., *Plant Pathologist*

No. 16, Iowa Park, Wichita County:
E. J. Wilson, B. S., *Superintendent*

Teachers in the School of Agriculture Carrying Cooperative Projects on the Station:

G. W. Adriance, M. S., *Associate Professor of Horticulture*
S. W. Bilsing, Ph. D., *Professor of Entomology*
V. P. Lee, Ph. D., *Professor of Marketing and Finance*
D. Scoates, A. E., *Professor of Agricultural Engineering*
H. P. Smith, M. S., *Associate Professor of Agricultural Engineering*
R. H. Williams, Ph. D., *Professor of Animal Husbandry*
A. K. Mackey, M. S., *Associate Professor of Animal Husbandry*
J. S. Mogford, M. S., *Associate Professor of Agronomy*
F. S. Jamison, M. S., *Associate Professor of Horticulture*

†As of October 1, 1929. *Dean, School of Veterinary Medicine.
**In cooperation with U. S. Department of Agriculture.
***In cooperation with the School of Agriculture.

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FORTY-FIRST ANNUAL REPORT, 1928

A. B. CONNER, Director

The Texas Agricultural Experiment Station is the agricultural research division of the Agricultural and Mechanical College of Texas. Agricultural research holds the same important relation to agriculture that industrial research holds to the development of industry, and we have many striking examples of great advances made in industry by reason of research work. We have also many notable examples of advancement and profit in agriculture as the result of research. In the face of these examples, however, it is a well-established fact that research serving industry is vastly better supported than research serving agriculture. The reason of this is that industrial research receives its support directly out of the profits of the business, being of such a character that it can be capitalized upon by the various agencies who are developing the various industrial lines. Agriculture, being a diverse occupation participated in by thousands and thousands of individuals, cannot support organized divisions of research to serve individual groups. Agricultural research, therefore, must depend on public support from the State and Federal Governments.

The amount of money invested in agriculture—in lands, livestock, and crops, totals enough to justify the exhaustive study of our important problems. Texas has a landed area of 168,000,000 acres and the value of her crops and livestock for each of the past three years was over a billion dollars. The Texas Agricultural Experiment Station, therefore, is serving an agricultural group which operates 168,000,000 acres of land which yields up a billion dollars annually.

Agricultural research is beneficial not only to those engaged in agricultural pursuits, but to other lines of business and industry, nearly all of which are affected rather directly by agriculture and agricultural conditions. One of the first functions of agricultural research is the development of agricultural knowledge which can be safely used by the Extension Service and by teaching agencies and all other agencies and organizations engaged in the dissemination of agricultural information for the benefit of agriculture and those engaged in it.

Agricultural Opportunities

Texas is confronted with vast agricultural opportunities and naturally with many serious problems in connection with realizing upon those opportunities. We have a vast cattle population; we are the leading State in wool and mohair production; we produce approximately 40

per cent of the nation's cotton crop; we are the leading State in the production of grain sorghum; we produce about 100 million bushels of corn and nearly a million tons of cottonseed meal annually; we have the largest grazing area of any State in the Union and produce vast quantities of roughages usable for growing and finishing livestock.

We ship out of Texas annually about a million head of cattle to be fattened and finished elsewhere, and at the same time ship out grain and other livestock feeds. We enjoy an unusual opportunity to develop the use of Texas feeds in producing meat, milk, eggs, wool and mohair, and in the process of feeding our own livestock on our own feeds to profit materially by altering our cropping systems and thus placing our agriculture on a sound basis. The full utilization of feeds grown can exert a marked influence upon soil fertility and upon the income of the crop farmer. The production of feed and its utilization in the diverse sections and the extent to which these feeds can be used profitably through livestock is a problem requiring serious study through research if we are to make the most of our opportunities in this field.

The problem of the cotton root rot disease is a serious one requiring intensive and persistent research work to develop a full knowledge of the life history of the cotton root rot fungus, its means of spread, and its behavior generally under field conditions before it will be possible to lay down effective and practical means of control or partial control of this destructive fungus disease. It may be that the solution of the cotton root rot problem lies in a change of our cropping system and the utilization of more feeds and more livestock on our farms. It is certain, however, that until we have a full knowledge of the fungus we will not know the best course of procedure to take. Cotton root rot disease causes an estimated loss of from $25,000,000 to $50,000,000 annually to Texas, and since Texas produces 40 per cent of the Nation's cotton crop, the control of this disease assumes not only a State but a National importance.

Soil fertility is becoming more and more an acute problem in connection with the practice of agriculture, particularly in the central and eastern parts of the State, and it bids fair to become an important problem in the western part of the State in the light of the wastage which is taking place on our lands through soil erosion. There is great need for intensive study of the whole soil fertility problem, including soil wastage by erosion and means of preventing not only soil wastage but as well a better basic understanding of the principles of renewing soil fertility under our existing conditions. The soil is the foundation of all our agricultural pursuits and its preservation and its fertility are of first importance to everyone engaged in agriculture and dependent in any way upon agriculture.

As a producer of horticultural crops, Texas ranks high, and the natural resources of Texas are such that we are assured of a substantial income from this source if the industry is developed in accordance with our opportunities. The growing of truck crops has developed in a remark-

able way and promises to become one of the State's great sources of wealth. The production of sweet potatoes, tomatoes, onions, potatoes, spinach, cabbage, watermelons, sweet corn, lettuce, and broccoli is already of major importance. Next in importance is the production of fruit crops. Peach, pecan, citrus, fig, strawberry, pear, grape, apple, blackberry and plum growing are major fruit industries. The recent development of the citrus industry in southern Texas may be cited as a notable example of the possibilities. This industry has added great wealth to the resources of the State. The potential date industry in southwest Texas, if developed, would apparently add millions of dollars to the agricultural wealth of Texas. The pecan industry, to which much of Texas is well suited, offers unusual opportunities for development. The production of ornamental crops, especially nursery stock, rose plants and bulbs is of importance. The processing of horticultural products, is assuming an important rank in the State. Texas ranks first in the production of canned and preserved figs, and the production of pickles, vinegar, cidar, canned blackberries, sauerkraut, canned tomatoes are typical industries.

Texas is so situated geographically that she has vast opportunities in the application of economic principles to agriculture. The soil and climatic conditions are such that improved farm machinery can be used extensively, thus reducing the man labor required and decreasing the unit cost of production, giving us an economic advantage over other sections less suited to extensive operation. The size of the unit, the organization of the enterprise, and an understanding of the principal factors which affect the total income from the farm or ranch are of the greatest importance in the development of a sound agriculture.

The Agricultural Experiment Station is, within its means, vigorously attacking these and other problems in a systematic way with the view of developing useful information applicable to Texas agriculture.

The succeeding pages contain a summary of the progress made during the past year on the many problems under investigation by the Agricultural Experiment Station, each of which has an intimate relation to the resources and wealth of Texas.

ORGANIZATION AND WORK

The Experiment Station System comprises the Main Station, at College Station, and appropriate divisions and scientific laboratories and experiment substations and field laboratories located in several regions of the State, as follows:

Divisions	Substations
Administration	No. 1, Beeville, Bee County
Veterinary Science	No. 2, Troup, Smith County
Chemistry	No. 3, Angleton, Brazoria County
Horticulture	No. 4, Beaumont, Jefferson County
Range Animal Husbandry	No. 5, Temple, Bell County
Entomology	No. 6, Denton, Denton County

Divisions

Agronomy
Plant Pathology and Physiology
Farm and Ranch Economics
Soil Survey
Botany
Swine Husbandry
Dairy Husbandry
Poultry Husbandry
Rural Home Research
Apiculture
Feed Control Service
Agricultural Engineering
Main Station Farm
Publications

Substations

No. 7, Spur, Dickens County
No. 8, Lubbock, Lubbock County
No. 9, Balmorhea, Reeves County
No. 10, College Station, Brazos County
No. 11, Nacogdoches, Nacogdoches County
No. 12, Chillicothe, Hardeman County
No. 14, Sonora, Sutton-Edwards Counties
No. 15, Weslaco, Hidalgo County
No. 16, Iowa Park, Wichita County

Research Field Laboratories

State Apicultural Research Laboratory, San Antonio, Bexar County
Research Queen Yard, San Antonio
Research Bee Outyard, Dilley, Frio County
Research Bee Outyard, Roxton, Lamar County
Research Bee Outyard, Seguin, Guadalupe County
Loin Disease Research Field Laboratory, Bammel, Harris County

Station Lands

The following table shows the lands owned and operated by the Agricultural Experiment Station System of the Agricultural and Mechanical College of Texas, for agricultural research purposes:

	Acres of Land Devoted to Various Uses			
	Area	Cultivate	sture	Farmstead, Roadways and Miscellaneous
Total	8,113.525	1,718.46	6,161.45	233.615
Main Station Farm	*127	82	29	16
Division of Veterinary Science	*141	5	130	6
State Apicultural Laboratory, San Antonio, Bexar County	10	4.5	4.5	1
Loin Disease Field Laboratory, Bammel, Harris County	†1,400.9	0	1,398.9	2
Substation No. 1. Beeville	151.5	104	28	19.5
2. Troup	152.6	62.5	84	6.1
3. Angleton	159.3	74	82	3.3
4. Beaumont	100	73	3	24
5. Temple	88.13	72.13	5	11
6. Denton	209.92	139	54	16.92
7. Spur	406.35	276	120.35	10
8. Lubbock	160	142	8	10
9. Balmorhea	200	80	110	10
10. College Station	‡901.8	240	630	31.8
11. Nacogdoches	81.6	35.4	36	10.2
12. Chillicothe	100	85	5	10
14. Sonora	3,461.63	59.93	3,390.7	11
15. Weslaco	100	72	3	25
16. Iowa Park	161.795	112	40	9.795

*Included in the main tract of College land.
†Leased land.
‡Includes 636 acres of the College's main tract and 265.8 acres purchased later for research purposes.

For the State fiscal year ended August 31, 1928, the inventories of the Texas Station totaled $1,099,370.33, exclusive of the property of the College now being used for Station purposes. This property, which consists of land at College Station, two brick buildings on the Campus, all carried on the College inventory and not repeated in the Station inventory, is valued at $169,449.69. The total value of all property being used at this time for the purposes of the Agricultural Experiment Station System is $1,268,820.02.

VETERINARY SCIENCE

Projects

1. Loin Disease of Cattle; Adams fund; H. Schmidt, leader.
2. Swellhead of Sheep and Goats; Adams fund; H. Schmidt, leader.
3. Swamp Fever of Horses and Mules; Hatch and State funds; H. Schmidt, leader.
4. Infectious Bovine Abortion Studies; Hatch and State funds; H. Schmidt, leader.
5. Stomach Worms in Sheep and Goats; State and local funds; E. A. Tunnicliff, Veterinarian, Substation No. 14, leader.
6. Duration of Immunity to Texas Fever; Hatch and State funds; R. P. Marsteller, Leader.

Loin Diseases of Cattle

The work in connection with loin diseases in cattle has been continued along the same general plan as in the past, and results obtained in the past have been substantiated. Thus, additional data have been accumulated showing that loin disease is due to the consumption of toxic bone and carcass material found on the range, but that not all carcass material is toxic or sufficiently toxic to produce loin disease when consumed by the animals. During the entire four years that the experiment has been under way, not a single animal was observed to contract loin disease that was not a bone chewer while on the other hand, a very large percentage of the bone-chewing animals contracted loin disease and died.

The object of the experiment was, therefore, to control or entirely eliminate loin disease by breaking the bone-chewing habit of the cattle by feeding mixtures of raw feeding bone-meal and fine salt. This has been kept in mind constantly and much data collected. These data indicate that the bone-chewing habit of animals on the Coastal Plains of Texas can be greatly checked but not entirely eliminated. Accordingly we also find losses from loin disease among animals receiving the bone-meal and salt mixture when the bone-chewing habit could not be broken among the cows, but on the whole about 1/6 as many cases of loin disease developed among the cows receiving bone-meal as developed among the control cows.

It could further be shown that besides greatly reducing the losses from loin disease the feeding of bone-meal and salt mixtures to range animals on the Coastal Plains of Texas was quite profitable in more

than one way. Thus, the trouble known as "creeps" in cattle did not develop among the cattle receiving bone meal while a large percentage of the control animals did develop this trouble. Furthermore, the mature cows receiving bone-meal and salt mixtures showed a greater per cent calf crop than the control animals, and such calves from animals receiving bone meal showed a larger weight and better quality when weaned than the calves from the control cows. Young growing animals on bone-meal and fine salt mixtures supplementing the range showed much more rapid growth and larger gains than similar control animals. It has, thus far, been determined that this advantage of the animals being fed bone-heal and salt mixtures continues until the animal is at least three years old. Whether it will be continued thereafter remains to be determined.

In our efforts to find a cheaper source of calcium and phosphorus than the raw feeding bone-meal we have tried superphosphate fertilizer mixed with cotton seed meal; also, dicalcium phosphate fertilizer, as well as spent bone black. The first two of these have thus far not given very encouraging results while the spent bone black showed some advantages. Just what the final value of these will be remains to be determined in further experiments.

Efforts were made to determine whether any other factor than calcium and phosphorus, and possible protein, is involved in causing the animals to chew putrid carcass material or whether the lack of either calcium or phosphorus alone could be responsible for this habit. During the first year that such experiments were undertaken we tried especially calcium alone in the form of limestone dust, giving 117 grams daily, and also salts of phosphoric acid in the form of either, 193 grams of sodium acid phosphate or 93 grams of acid potassium phosphate. Furthermore, a combination of 100 grams of potassium sulphate and 50 grams of potassium bicarbonate in addition to three ounces of bone-meal per day and finally 100 gm. potassium sulphate plus 50 gm. potassium bicarbonate plus 110 grams of acid potassium phosphate daily. The animals were drenched individually every day except Sunday and this continued for a whole year. No effects on the bone-chewing habit could be observed.

During the year, additional toxic carcasses have been found among the animals dying from loin diseases on the grounds of the Laboratory. Experiments showed that in one case the toxic bone retained its toxicity for a period of more than one year when the toxic bones were exposed to weather conditions for six weeks but not thereafter and that as small a quantity as two pounds of this bone consumed by an animal weighing about 875 pounds was sufficient to bring on an acute attack of loin disease. It indicates that under favorable conditions the putrid bones and other carcass material may remain toxic on the prairie for a long time and thus constitute a danger for the animals afflicted with the bone-chewing habit.

During the year a large number of bacteriological cultures were made in an effort to isolate the organisms in pure culture and also studies

of the conditions on which the organisms produced its toxin. The precise conditions necessary for the production of this toxin have not yet been determined, since toxin production has been very irregular, even in the same batch of culture media. We have succeeded, however, in passing the toxic material through one cow and from there through 13 subcultures, the last of which again proved to be toxic for a cow. This is considered excellent evidence that the toxin is produced by some specific organism that grows under anaerobic condition, but under which we have not yet been able to isolate a pure culture. Until our efforts to isolate the organism in pure culture are successful, little progress can be made on the precise nature of the organism, and the conditions most suitable for the production of toxin.

It was further established that the same material which proved toxic for cattle was also toxic for guinea pigs in small amounts, but until the organism is isolated in pure culture it cannot be proven that the material killing the cow and the material killing the guinea pig are identical. Assuming, however, that the two substances are identical, and using the guinea pig to establish the toxicity, a search was made to establish the further distribution of the organism in question. We have in this manner been able to obtain a toxic culture from water standing in a pond, from the soil collected from the spot where an animal died from loin disease, and also from some carcasses which did not prove toxic to cows in the amounts of materials used in the test. If we were really dealing with loin disease toxin in these tests, then they go to show that the organism responsible for loin disease toxin may have a wider distribution in nature and indeed may be constantly found in the intestinal tract of all animals in the affected area ready to escape into the tissue of the animals after death and there to produce its toxin.

Since it has been definitely established that loin disease is caused by a toxin liberated by an organism in putrid bones and other carcass material, it is obvious that the removal of bones and carcass material from the range is sound procedure in avoiding the disease. It is also possible in a large number of cases to prevent animals from picking up toxic bones and material by feeding bone-meal, with the result that increased growth and development of the animals is attained. Perhaps the safest course of procedure at the present time is to follow the practice of removing bones and carcass material from the range and at the same time feed bone meal in order to supply needed elements for the proper growth and development of the animals in sections where loin disease is prevalent.

Swellhead of Sheep and Goats

The work under this project is assigned to the Veterinarian at the Substation No. 14, Sonora. However, some work on this subject has been carried on at the Main Station.

A detailed report of work carried out at the Main Station last year has already been made in the Fortieth Annual Report, Page 11. Dur-

ing the present fiscal year three other goats suffering from the same trouble and exhibiting the same symptoms and pathological lesions as already reported were received at the Main Station for further study. From one of these goats a long chained streptococcus growing anaerobically was again isolated, together with a number of other organisms. The other two goats were negative culturally, but in one of these a long chained streptococcus was found in smears from the kidney, together with some bacilli.

A two-year-old angora goat of our own raising was inoculated with 8 cc. of a forty-eight-hour cube liver buillon culture of the streptococci isolated from one of the above goats. The angora goat inoculated was rather weak, and when placed in a stall refused to eat good alfalfa or prairie hay, and also refused a mixture of wheat bran and corn chops. It, therefore, became rapidly weaker so that on the second day of inoculation it could no longer get up. Four days after the inoculation the animal was therefore destroyed and cultures were made from the spleen, kidneys and liver. Streptococci were again found in two out of six tubes made from the spleen, in four out of six made from the kidney, and two out of six tubes made from the liver. Another goat was inoculated with 10 cc. of forty-eight-hour cube liver bouillon culture with the streptococci obtained from the kidney of the above inoculated goat. The goat inoculated, however, had previously been injected intravenously with 5 cc. of blood drawn from one of the three goats sent in, cultures of which were negative, but in which streptococci were found in smears from the internal organs. The goat had shown no reaction during the following 30 days and for that reason was again used in this experiment. Five months later this goat was found to be very weak. It would often fall down and be unable to get on its feet again. Post mortem examination of the goat showed ascites, hydrothorax, and hydropericardium. In the kidney a slight trace of jaundice was found in the cortex. The remaining organs were clean. The body fat was jelly-like, edematous. No stomach worms were found. The results of cultures from this goat are not yet available.

Another goat was drenched with 125 cc. of urine obtained from one of the three goats sent in, cultures from which were negative, but in which streptococci were found in smears from the internal organs. The goat did not show any ill effects during the following 30 days and was therefore again inoculated with 10 cc. of cube liver bouillon of a tiny bacillus obtained from one of the three goats sent in. Five months later this goat also became rather weak. Cultures made from the blood of this goat were negative. The goat died a few days later during the night and decomposition was so far advanced that additional cultures could not be made from the organs. Post mortem examination also showed that the goat was suffering from ascites, hydrothorax, and hydropericardium.

At the Ranch Experiment Station, Sonora, an outbreak of Swellhead occurred among the goats on March 12, 1928, the last case being found on April 17. During this time 11 angora goats developed con-

ditions indistinguishable from Swellhead. With these cases of Swellhead a number of experiments were carried out. The Swellhead goats were fed in dry lots among healthy ewes, rams, lambs, bucks, does, kids, and chevons for over a month without the development of a new case.

Recovered Swellhead goat specimen 55, with an average infestation of goat louse, *L. stenopsis,* was placed in a dry feed lot with one healthy chevon and about twenty ewes for over a month without the development of a new case. It was thought possibly the blue louse might carry the disease.

Various emulsions of the parenchymatous organs and whole blood from Swellhead goats were inoculated into two-year-old chevons. A healthy two-year-old chevon and ewes were placed in contact with the infected goats without the appearance of a new case.

Swamp Fever in Horses and Mules

The clinical observation of the two animals reported in the 1927 Annual Report was continued but no additional treatments administered. The results finally showed that an intravenous infection of tarter emetic when 10 to 12 injections of 25 to 40 cc. of three per cent solution was given, was not effective in producing a cure. Thus, both of the animals reported suffered a subsequent attack of Swamp Fever and both succumbed to that attack.

Work on this project has been discontinued temporarily on account of lack of material and lack of time in connection with other and more important projects and subject to reinstatement when conditions permit.

Infectious Bovine Abortion Studies

Vaccination of cows of the dairy herd of the Feeding and Breeding Station with live cultures of Brucella abortus (Bang) was continued, using the same method as already outlined in past reports. Such vaccinations have been conducted now for three successive years, the results of which can be summarized as follows: During the 10 years immediately preceding the time when vaccination was started in the herd the average percentage of abortions was 23.76. The lowest percentage recorded in any one year during these ten years was 11.5. Our data show that during the three years that vaccination was practiced in this herd there were 91 conceptions and 5 abortions, giving us 5.5 per cent abortion in the herd. Furthermore, the 91 conceptions required 137 services, or an average of 1.5 services per conception. It will thus be seen that the breeding efficiency of the herd had not suffered due to the fact that vaccination with live cultures of Brucella abortus (Bang) was practiced on all animals of the herd and that the percentage of abortions has been materially reduced. It should be noted that the 5 abortions above recorded are credited to four animals, two of which were chronic abortors before vaccination was started.

Stomach Worms of Sheep and Goats

Work at the Main Station on Stomach Worms of sheep and goats was conducted during the past year and the experiments were carried out with tetrachlorethylene in soft gelatin capsules using 5 cc. for mature animals and 2½ cc. for kids. The animals were not deprived of food and water before the drug was administered, but were kept away from food and water after the administration of the drug until destroyed for post mortem examination, which time varied from 6 to 15 hours. Stomach worms were found in all post mortem examinations in 140 goats thus treated. Out of these 140 goats all stomach worms had been destroyed in 114. In the remaining 26 goats, the percentage of kill varied from zero to 99.1 per cent, with an everage kill of 23.11 per cent, which gives us a grand average of 92.86 per cent stomach worms destroyed by the treatment. This work seems to indicate that tetrachlorethylene is effective in killing stomach worms and is a practical means of control, provided we can eliminate or at least materially reduce the factors responsible for the exceptional ineffective cases noted.

Anaplasmosis

A disease of cattle well known in South America and in Africa as Anaplasmosis has recently been reported from California, Kansas, Oklahoma, and Florida, where heavy losses from this disease have been sustained. This disease had not been conclusively reported from Texas. During the past winter seven Brown Swiss bulls were sent to the Texas Agricultural Experiment Station from Rapid City, South Dakota, to be immunized against Texas fever. These bulls were inoculated with virulent Texas fever blood on three different occasions, but none of them reacted to the inoculation. The last inoculation was made 18 days before the animals left the Station. On the 13th day after the last inoculation, two eighteen-months old steers known to have been free of ticks all their lives were inoculated with the blood of two of the Brown Swiss bulls. One of these steers showed a light reaction on the 33rd day while the other steer showed reactions on the 5th, on the 7th to 10, and again on the 12th to 15th day, after which time he remained free until the 36th day when a very severe reaction set in lasting for six days. During this last reaction the animal became very thin and was off feed for one day. No Texas fever organisms could be found in smears made during a fever reaction from the blood of an ear vein of this steer on the 13th and 14th day after inoculation. Smears made from the blood of an ear vein during the last reaction, and 38 days after the inoculation of the animal, showed many anaplasma-like bodies measuring .3 to .9 microns in diameter in the red corpuscles. A count in 10 microscopical fields with a total of 817 erythrocytes showed a total infection of 29.37 per cent. How long previous to the 38th day after inoculation these bodies had appeared in the blood is not known, but after the discovery of these bodies they persisted for 10 days. The

smears made from this animal also showed typical blood changes as reported to be observed in anaplasmosis.

CHEMISTRY

Projects

1. Nutritive Values of Feeds; Adams fund; G. S. Fraps, leader.
2. Soil Studies; Adams fund; G. S. Fraps, leader.
3. Plants, Their Composition and Properties; Hatch and local funds; G. S. Fraps, leader.
4. Composition and Properties of Texas Soils; Hatch and local funds; G. S. Fraps, leader.
5. Human Food; Its Composition, Properties, Utilization, and Preservation; Hatch and local funds; G. S. Fraps, leader.
6. Feed Analyses and Investigations; Feed Control and local funds; G. S. Fraps, leader.
7. The Value of Sulphur to Texas Soils and Crops; co-operative study; funds provided by Freeport Sulphur Company; G. S. Fraps, leader.
8. Pecan Soils in Texas; State and local funds; G. S. Fraps and W. T. Carter, leaders.
9. Variation in Vitamin Content of Texas Foods; Purnell fund; G. S. Fraps, leader.
10. Nitrification. A Study of the Relation of Nitrification to Soil Fertility; Purnell fund; G. S. Fraps, leader.

Soils

The study of the relation of the potash of the soil to its chemical composition has been continued. A bulletin which discusses the relation of the water-soluble potash, replaceable potash, and potash-soluble in 12 per cent acid to the active potash and the potash given up to plants in pot experiments is nearly ready for publication.

Chemical analysis and pot experiments have been made upon a number of samples of typical soils. Texas Station Bulletin No. 375, entitled "The Soils of Bowie, Denton, Freestone, and Red River Counties," has been published and another bulletin of the same character is in preparation. A pot experiment on a soil from North Texas, on which milo and some other crops suffered badly from chlorosis, shows that an application of gypsum corrects this condition in the surface soil, while both iron sulphate and gypsum correct it in the subsoil. This work is being continued.

Nitrification

A study of nitrification in different soils was begun in the fall of 1927. Mr. A. J. Sterges, Assistant Chemist, has devoted his entire time to this project. Preliminary investigations were made regarding the manner of conducting the tests and the methods of analysis. Comparative studies of the nitrification of various typical samples showed decided variations between the different types, with both sulphate of ammonia and cottonseed meal. Some of the soils not only refused to nitrify the sulphate of ammonia added, but nitrified the soil nitrogen to a smaller extent. Many of these soils were not acid before or after

the nitrification. Attention is now being directed to the various factors which might increase nitrification in these soils, in order to ascertain the causes of the wide variation exhibited by them.

Sulphur

The collection of samples of rain water for analysis in connection with the sulphur project was discontinued in May, 1928. The results of the work are being prepared for publication. There is a possibility that sulphur may be of benefit to certain exceptional soils or under unusual conditions, and this possibility will be further explored.

Salt Water on Rice

The results of a limited study of the effect of salt water on rice were published in Texas Station Bulletin No. 371, entitled "The Effect of Salt Water on Rice." It is difficult to establish a limit to the amount of salt in the water to be used for the irrigation of rice, but it appears best to stop pumping when the water contains over 50 grains of salt to the gallon.

Cotton Root Rot Investigations

Chemical investigations in connection with the cotton root rot work have been continued in cooperation with the Division of Plant Pathology and Physiology. These investigations have been very largely concerned with the relation of the acidity and basicity of the soil to the occurrence of root rot, although other factors have also been investigated. A bulletin manuscript is being prepared which deals with the basicity of the soils in various sections of the State.

Nutritive Values of Feeds

No digestion experiments were made during the past year, for the reason that the chemical work on samples from previous digestion experiments had not been completed and it was considered necessary to discontinue the experiments until this work had been completed. A considerable amount of analytical work was done on the samples already collected.

Texas Station Bulletin No. 372, entitled "Digestibility and Production Coefficients of Poultry Feeds," was released for distribution in January, 1928. This Bulletin contains the results of 63 digestion experiments on poultry, together with a compilation of all other digestion experiments that could be found. The Bulletin contains coefficients for calculating the digestible protein and productive values of poultry feeds. The average composition and productive values of poultry feeds are given and also a method for calculating the composition and feeding values of mixed feeds for poultry.

Vitamin Work

The vitamin work has been continued, special attention having been given to the vitamin A content of corn secured from the substations in various parts of the State. Yellow corn contains about three times as much vitamin A as strawberry corn and about one hundred times as much as white corn. There does not seem to be much difference between the vitamin A contained in yellow corn and in alfalfa meal as placed on the market. Turnip greens were found to be very high in vitamin A.

The vitamin A content of butter is being estimated at different seasons of the year. A very great difference was found between the butter secured during the winter and that secured in the summer. The pastures were unusually green this summer, which may have given a higher vitamin A content to the butter than is usually the case during the summer drouth. This study is being continued.

Feed Analyses

During the year, 3,115 samples were analyzed for the Feed Control Service. This includes not only the complete feed analyses, but also a microscopic examination, together with some poison tests, and some estimations of special ingredients, such as limestone, mineral, or salt. Changes in the definitions of some of the feeds are also being studied.

Fertilizer Control

Inspections and analysis of fertilizers sold under the fertilizer law have been made as usual under the direction of the State Chemist. The results for 1926-27 have been published in Texas Station Bulletin No. 368, entitled "Commercial Fertilizers in 1926-27, and Their Use," and a bulletin giving the results for the season of 1927-28 has been completed. The bulletins contain information regarding the use of fertilizer as well as statistics and the report of operations under the fertilizer law.

Miscellaneous

Green Sand Marl: Extensive deposits of green sand marl, unusually high in potash and phosphoric acid, occur near San Antonio, Texas. While the plant food content and availability is hardly high enough to justify marketing as commercial fertilizers, these deposits should have some value. Samples are being examined by means of chemical analyses and pot experiments.

Arsenic in Honey: Analyses of samples of honey made by bees fed on cotton which had been poisoned with calcium arsenate showed the honey to contain practically no arsenic.

Sewage Sludge: Considerable quantities of sewage sludge are being thrown away in different sections of the State. Chemical analyses and other studies are being made to ascertain the possible value of this sewage sludge.

Association of Official Agricultural Chemists Work: The Chief of the Division of Chemistry is referee on fertilizers and is a member of the Committee on Definitions of Terms, and Interpretation of Results for the Association of Official Agricultural Chemists.

Shrimp Refuse: A considerable quantity of shrimp heads is being wasted at the packing plants near Palacios, Aransas Pass, and other sections of the State. The chemical analysis of sample shrimp refuse shows that it has a high fertilizer value and should be dried and saved.

Composition of Figs: In cooperation with the Division of Horticulture, chemical analyses are being made of a number of samples of figs.

School for Fertilizer Salesmen: The Chief of the Division of Chemistry assisted in a School for Fertilizer Salesmen at Troup, Texas, September 15, 1928, and also at College Station, August, 1928.

Bags Which Injured Onions: The chemical analysis of a bag submitted to the Division of Plant Pathology and Physiology, in which bag onions were damaged by the formation of a black spot where they touched the bag, showed that the bag contained an alkaline substance which acted upon the skin of the onions. While the onions were slightly injured, the injury was only on the surface and did not affect the value of the onions for eating purposes.

National Fertilizer Conference: The Chief of the Division of Chemistry attended the First National Fertilizer Conference held at Louisville, Kentucky, in September, 1927, and aided in the formulation of a very comprehensive program, which includes national uniformity, restriction in the number of grades of fertilizers and encouragement for research in various lines related to fertilizers.

Composition of Eggs: Analyses of samples of eggs from hens fed rations containing cottonseed meal or tankage showed differences in chemical composition. This work is being continued in co-operation with the Division of Poultry Husbandry.

Composition of Grasses: Chemical analyses are being made of a number of samples of grasses submitted by the Division of Veterinary Science in connection with the work on the loin of disease of cattle.

Salt in Feeds: A simple method for the estimation of salt (sodium chloride) in cattle feed is being studied.

HORTICULTURE

Projects

Section of Fruit Crops:

1. Adaptability Investigations with Fruit Crops; Leaders: R. A. Hall, P. R. Johnson, R. H. Stansel, R. H. Wyche, Henry Dunlavy, B. F. Dana, P. B. Dunkle, R. E. Dickson, D. L. Jones, J. J. Bayles, H. F. Morris, J. R. Quinby, J. C. Stephens, W. H. Friend, W. H. Dameron, V. L. Cory, W. J. Bach, E. J. Wilson, J. P. Lusk, H. Ness, and H. P. Traub; State funds.
2. Standardization of Blackberry and Dewberry; P. R. Johnson and H. F. Morris, leaders; State funds.
3. Fertilization, Thinning, Pruning and Staking of the Blackberry and Dewberry; P. R. Johnson and H. F. Morris, leaders; State funds.
4. Breeding of Superior Varieties of the Blackberry; P. R. Johnson and H. F. Morris, leaders; State funds.
5. Standardization and Breeding of Citrus Fruits; W. H. Friend, leader; State funds.
6. Citrus Root-Stocks; W. H. Friend, leader; State funds.
7. Fertilization, Cover Crops, and Irrigation in Grapefruit Production; W. H. Friend, leader; State funds.
8. Standardization of Date Varieties; W. H. Friend, leader; State funds.
9. Propagation of the Date; W. H. Friend, leader; State funds.
10. Pollination of the Date; W. H. Friend, leader; State funds.
11. Cultivation, Fertilization, and Irrigation of the Date; W. H. Friend, leader; State funds.
12. Standardization and Breeding of the Fig; R. H. Stansel, leader; State funds.
13. Fertilization of the Fig; R. H. Stansel, leader; State funds.
14. Pruning of the Fig; R. H. Stansel, leader; State funds.
15. Spraying of the Fig for Disease and Insect Control; R. H. Stansel, leader; State funds.
16. Standardization and Breeding of the Grape; J. J. Bayles, leader; State funds.
17. Fertilization, Irrigation, Pruning and Training of the Grape; J. J. Bayles, leader; State funds.
18. Breeding of Superior Varieties of the Peach; P. R. Johnson and H. F. Morris, leaders; State funds.
19. Fertilization of the Peach; P. R. Johnson, leader; State funds.
20. Standardization and Breeding of the Pecan; G. W. Adriance, leader; State funds.
21. Fertilization of the Pecan; F. R. Brison and G. W. Adriance, leaders; State funds.
22. Propagation of the Pecan; F. R. Brison, leader; State funds.

Section of Truck Crops:

1. Adaptability Investigations with Truck Crops; Leaders: R. A. Hall, P. R. Johnson, R. H. Stansel, R. H. Wyche, Henry Dunlavy, B. F. Dana, P. B. Dunkle, R. E. Dickson, D. L. Jones, J. J. Bayles, H. F. Morris, J. R. Quinby, J. C. Stephens, W. H. Dameron, V. L. Cory, W. H. Friend, W. J. Bach, E. J. Wilson, J. P. Lusk, H. Ness, and H. P. Traub; State funds.
2. Fertilization and Irrigation of Asparagus; E. J. Wilson, and J. J. Bayles, leaders; State funds.
3. Fertilization and Irrigation of Cucumbers; E. J. Wilson and J. J. Bayles, leaders; State funds.
4. The Use of Mulches in Truck Crop Production; P. R. Johnson, H. F. Morris, R. H. Stansel, W. H. Friend, E. J. Wilson and J. J. Bayles, leaders; State funds.

5. Purification of Strains of Honey Ball Melon; E. J. Wilson, H. F. Morris and J. J. Bayles, leaders; State funds.
6. Standardization of Mustard Strains; R. H. Stansel, leader; State funds.
7. Breeding of Superior Quality Wilt-Resistant Tomato Varieties; H. P. Traub, J. J. Taubenhaus, P. R. Johnson, W. H. Friend and W. N. Ezekiel, leaders; State funds.
8. Fertilization, Pruning and Staking of the Tomato; P. R. Johnson, H. F. Morris and W. H. Friend, leaders; State funds.
9. Irrigation and Spacing of the Tomato in the Lower Rio Grande Valley; W. H. Friend, leader; State funds.
10. A Fundamental Research Into the Cause of "Tomato Pockets"; H. P. Traub, J. J. Taubenhaus, P. R. Johnson, W. H. Friend and W. N. Ezekiel, leaders; State funds.
11. The Morphology and Physiology of "Tomato Pockets"; F. L. Jamison, leader; State funds.

Section of Ornamental Crops:

1. Adaptability Investigations with Ornamental Crops; Leaders: R. A. Hall, P. R. Johnson, R. H. Stansel, R. H. Wyche, Henry Dunlavy, B. F. Dana, P. B. Dunkle, R. E. Dickson, D. L. Jones, Frank Gaines, J. J. Bayles, H. F. Morris, J. R. Quinby, J. C. Stephens, W. H. Dameron, V. L. Cory, W. H. Friend, W. J. Bach, E. J. Wilson, J. P. Lusk, H. Ness and H. P. Traub; State funds.
2. Standardization and Breeding of the Crape Myrtle; R. H. Stansel, leader; State funds.
3. Fertilization and Pruning of the Crape Myrtle; R. H. Stansel, leader; State funds.

Section of Horticultural Products:

1. Factors Affecting Quality in Fruits; H. P. Traub, leader; State funds.
2. Canning, Preserving, Pickling, Etc., of Horticultural Crops; H. P. Traub, leader; State funds.
3. Dehydration of Horticultural Crops; H. P. Traub, leader; State funds.

Adaptability Investigations with Fruit Crops

Adaptability investigations with fruit crops are conducted at the Main Station Horticultural Farm, and at each of the Substations. Since 1888, a great number of fruit varieties have been received for study as to their possible adaptability to the various sections of Texas. Notable introductions have been announced in previous reports. Two subjects are recommended this season.

Bruce Plum: One of the most promising fruit varieties recommended this season is the Bruce plum, which was originated by the late A. L. Bruce, Clarendon, Texas. It is a large red-colored, high-quality fruit which matures before the dry season has progressed far, and may be picked in the green condition for shipment. This variety apparently is suitable for use as the basis of a commercial plum industry in Texas. This variety, together with the Methley plum, recommended in former reports, should provide the commercial grower, as well as the home gardener, with suitable material until even better varieties are produced by systematic breeding methods.

Tung Oil Tree: After 20 years' trial at the Troup Substation, the Division considers it safe to recommend the commercial planting of the

Tung Oil tree, *Aleurites fordii,* in East Texas and possibly also in the Gulf Coast region of the State. The tung-oil industry has become definitely established in Southern United States. The demand for this product is due to the fact that the production of many types of modern industrial paints and enamels calls for the use of substantial amounts of water-resisting varnishes. For this purpose, one of the chief raw materials used is tung oil, which is expressed from the nut-like seed of *Aleurites fordii.*

The tung oil tree appears to be capable of development as a crop of secondary importance on cheap, well-drained, sandy clay soils, where there is an annual rainfall of twenty-five inches or more, and where the temperature does not often go lower than ten degrees F. In order to encourage uniformity in the product it was considered advisable to name two outstanding varieties now growing at the Troup Substation. The TROUP variety (T. S. No. 11679) makes a tall tree, is a prolific bearer, fruits round; the TAES variety (T. S. No. 11678) makes a smaller tree, and the fruits are larger and angular.

A limited amount of seed and budwood will be distributed over the period 1931-32, to those interested, depending upon the supply available each season and the number of applicants.

Date Production

The work with dates started at Texas Substation No. 15, Weslaco, in 1926-27, has been continued. Offshoots of additional varieties have been planted during the summer. Apparently, a higher percentage of these offshoots will survive than was the case with former plantings. The project undertaken by the United States Department of Agriculture, with funds provided by act of Congress for securing and testing moisture resistant varieties of dates, will give an added impetus to the work already under way in this State. The work contemplated by the Division of Horticulture includes the standardization of varieties, and studies in propagation, pollination, cultivation, fertilization, and irrigation of the date.

Blackberry and Dewberry Production

The blackberry industry has assumed considerable commerical importance in East Texas. In the vicinity of Lindale, Smith County, alone nearly 1,000 acres are devoted to blackberry culture. In keeping with the increasing importance of this crop, the Division of Horticulture has initiated comprehensive experiments covering the problems of the blackberry growers. This work was made possible with funds provided by special State appropriation for horticultural research at Texas Substations No. 2 and 11, Troup and Nacogdoches. More than 45 varieties of the blackberry and over 12 varieties of the dewberry and loganberry have been procured in order to make a thorough search for the best available varieties already in the trade. Experiments in the

fertilization, thinning, staking, and pruning of the blackberry and dewberry have been initiated, and the work in berry breeding already under way has been enlarged to include the breeding of a superior variety of the blackberry with less acidity and a higher sugar content. These projects are carried out primarily at Troup and Nacogdoches.

The work with the Nessberry at the Main Station Horticultural Farm has been continued. The back crosses of Nessberry, 2nd, 3rd, and 4th generation selfs, on the raspberry (Halisham, and Brighton), the blackbery (Early Harvest), and the dewberry (Louisiana) are calculated to correct some of the shortcomings of the Nessberry. Progeny numbering 686 were planted out at the Main Station Horticultural Farm during May. These have practically all survived and will come into bearing during the coming season.

Grape Production

The experience of practical growers in various parts of the State over a long period of years has shown that grape culture on a commercial basis is practicable. The present 1,000 tons commercial production should be considerably increased in the future.

In regions subject to root rot infestation, this disease is apparently the critical factor. The Division of Horticulture is cooperating with the Division of Plant Pathology and Physiology in a search for a grape root-stock that will be resistant to root rot. Should the quest prove successful, the next step will be to study the compatibility between this root-rot-resistant stock and the scions of desirable varieties.

Both the European and the American types of the grape can be grown successfully in Texas. The European varieties are relatively more drouth-resistant than the American types. The latter, however, are more frost-resistant than the former and can be grown farther north.

Work has been initiated with vinifera varieties at Texas Substation No. 9, Balmorhea. An adaptability study covering several years has shown that Tokay, Mission, Malaga, Cornishon, and some other varieties are well suited to the conditions represented on the Substation grounds. Although late spring frosts may nip the early shoots in some seasons, new shoots will replace them. The work undertaken includes standardization of varieties, the pruning, training, fertilization, cultivation, irrigation, and breeding of the vinifera grape.

Citrus Production

The work with citrus fruits, carried on at Texas Substation No. 15, Weslaco, is concerned with the following: (1) orchard management, cultural methods, cover crops, fertilization, and irrigation; (2) citrus root-stocks, and (3) standardization and breeding.

The object of the experiments with cultural methods and cover crops is to determine the relative value of the various cultural practices in

grapefruit production. The fertilizer work has for its object the determination of the best balanced proportion of the critical nutrients (analysis or grade of fertilizer), and the most profitable amounts to apply in grapefruit production under Texas conditions. The data covering the years 1924-1928 will be treated statistically during the fall, and this information will be used as a basis for planning further experiments on orchard management. A study of the irrigation-water requirements of the grapefruit is being initiated in order to secure quantitative data upon which to base recommendations to growers.

Experiments with citrus root-stocks are being initiated. The chief commercial varieties of the grapefruit, orange and mandarin, grafted on Cleopatra mandarin, sour orange, rough lemon, and trifoliata root-stocks, are to be studied. The standardization of citrus varieties was continued, and plans are being made to begin work on citrus breeding.

Fig Production

The experiments with figs, carried on at Substation No. 3 and 4, Angleton and Beaumont, and at the Main Station Horticultural Farm, include the following: (1) fertilizer requirements of figs, and the effect of liming the soil on fig production; (2) pruning the fig trees; (3) spraying for insect and disease control, and (4) standardization of fig varieties, and breeding.

The fertilizer work with figs has not been carried out over a sufficient period to yield conclusive results. Liming the soil apparently has increased the yields. No beneficial results have been secured by the use of sulphur and this work is being continued.

The pruning experiments with figs apparently show that heavy pruning leads to late maturity as compared with moderate, light, or no pruning. Trees heavily pruned mature fruit over a longer period than those lightly pruned. Since the great proportion of the Texas fresh fig crop is marketed at the local preserving plants, the practice of heavy pruning generally followed by practical growers should be the usual procedure.

Experimental work with spraying for the control of fig rust was continued. The results of the present year apparently substantiate the earlier conclusion that application of Bordeaux 5-5-50, at intervals of 30 days, beginning as soon as the disease appears about July 15, until about September 15, is the most profitable method of control.

The standardization work with figs to date has not revealed a variety superior to the Magnolia. The work, however, is being continued, and a thorough survey is planned. Work in fig breeding is also contemplated.

Peach Production

The experimental work with the peach has been temporarily interrupted as a result of the serious damage by hail to the experimental peach orchard at Substation No. 2, Troup, in the summer of 1926. During the present season projects covering the fertilization of the peach

orchard and peach breeding have been initiated, supported by funds provided by special State appropriation for horticultural research at Substations Nos. 2 and 11, Troup and Nacogdoches.

The object of the fertilizer experiment is to determine the best balanced proportion of critical nutrients (analysis or grade), and the amount of such well balanced formula to apply under East Texas conditions. The experiment will be carried out at Substation No. 2, Troup, and in cooperation with practical growers in East Texas. The chief commercial variety in this State, the Elberta, is used in the experiment. The trees, for the new three-acre orchard at Substation No. 2, Troup, will be budded on Mariana plum root-stocks. The buds used will be taken from one tree with a known superior performance record.

The object of the breeding experiment with the peach, carried on at Substations No. 2 and 11, Troup and Nacogdoches, is the production of varieties that are more frost-hardy in bud and flower, and with quality as good as Elberta. Promising parents have been chosen during the past season, and the crosses will be made during the coming spring.

Pecan Production

The fundamental researches into the sterility and nutrition in the pecan have been continued. Work is also under way on a study of graft unions in pecans.

Adaptability Investigations with Truck Crops

Adaptability investigations with truck crops have been continued. The Fargo and Viking tomato varieties introduced by the North Dakota Station were tried out at Substations No. 2 and 15, Troup and Weslaco. Both varieties were a failure at Troup, but encouraging results were obtained at Weslaco, where these varieties were apparently less subject to "blossom drop" than other varieties. Toward the end of the season plans were made to determine the adaptability of Pyrethrum, *Chrysanthemum cinerareaefolium,* Vis. commonly called Dalmatian Insect Powder Plant, to certain localities in Texas.

Asparagus and Cucumber Production

In the irrigated sections of North and West Texas subject to root-rot infestation, asparagus and the cucumber are promising commercial truck crops. In order to supply practical information to the growers in these regions experiments in the fertilization and irrigation of asparagus and the cucumber have been planned at Substations No. 9 and 16, Balmorhea and Iowa Park.

Melon Production

The Honey Ball Melon, developed in Texas and now recognized as an important commercial variety, is quite variable. In order to standardize this variety an experiment has been planned at Substations Nos. 9,

11, and 16, Balmorhea, Nacogdoches, and Iowa Park, with the object of fixing a definite type by selection within self-fertilized lines.

Mustard Standardization

During the present season plans were made to carry on a project with the object of standardizing mustard strains. This work will be located at Substation No. 3, Angleton.

Tomato Culture

A comprehensive experiment covering the fertilization, pruning, and staking of the tomato has been initiated. This work will be carried out at Substations No. 2, 11, and 16, Troup, Nacogdoches, and Weslaco. This work at Troup and Nacogdoches is made possible by a special State appropriation for horticultural research work at these substations.

Tomato Pockets

The condition known as "Tomato Pockets" has become a serious problem in the chief commercial tomato-growing sections of this State. The loss from this source is estimated at more than fifteen per cent of the fruit grown. A fundamental research into the cause of "Tomato Pockets"* is well under way. During the past season, in the field, a relatively high correlation between virus infection and "tomato pockets" was observed. At the Main Station Horticultural Farm, experiments are under way to determine any possible causal relationship as associated with the correlation observed in the field. The Division of Plant Pathology and Physiology is cooperating in this phase of the problem. If the observed correlation should prove coincidental, the effect of other environmental factors will next be studied. During the past season also the types of "Tomato Pockets" were classified, and a study of the anatomy and morphology of the "pocketed" tomato was initiated.

Wilt-Resistant Tomato Varieties.

The work of Dr. Stakman and co-workers at the Minnesota Station has shown that breeding for resistance to parasitic disease for one region may not solve the problem for other regions, due to the existence of local physiological strains of the parasite. Wilt- (*Fusarium lycopersici*) resistant varieties of the tomato developed elsewhere have not proved satisfactory under Texas conditions. During the present year plans were made in cooperation with the Division of Plant Pathology and Physiology to begin work with the object of developing wilt-resistant varieties of the tomato for the various commercial tomato regions of this State. This work will be carried on at the Main Station Horticultural

*There are many local variations in nomenclature, "Puffy tomato," "Tomato Puff," "Tomato Pops," and so forth. These do not adequately describe the disease. After classifying the various types of the disease, Traub, Hotchkiss and Johnson (1928) have proposed the term "Tomato Pockets."

Farm, and at Substations No. 2, 11, and 15, Troup, Nacogdoches, and Weslaco.

Use of Mulch Paper in Tomato Production

Mulch paper has been used for many years in the production of pineapples in Hawaii, and recently attempts have been made to extend the use of mulch paper to the production of horticultural crops in cases where the return per acre is sufficient to warrant the extra outlay. Preliminary experiments carried on by the United States Department of Agriculture have given encouraging results, and it appears advisable to begin similar work under our local conditions. The major effort will be directed toward the tomato, but a limited amount of exploratory work of this nature will also be carried on with fruit and ornamental crops.

Adaptability Investigations with Ornamental Crops

Adaptability investigations with ornamentals have been carried on since the organization of this Station in 1888. Many valuable recommendations have been based upon the work carried on to date. Recently, however, requests for definite recommendations as to the ecology of ornamentals, the effect of the sum total of environment factors upon the plant, have been so numerous that it was thought advisable to enlarge the scope of the project to include quantitative measurements such as height, width, blooming period, etc., as well as general observations. In order to give the project a definite form, the cooperation of the substation staffs has been enlisted. The method of procedure includes the adoption by each substation of a definite type of landscape design which fits naturally into the climatic region where it is located. Provision will be made for the use of ornamentals suitable for each climatic region in carrying out the details. In this manner fine examples of the classical types of landscape design will be produced which will provide inspiration for local landscape designers.

Crape Myrtle

One of the many valuable ornamental crops of Texas is the Crape Myrtle, which blooms during practically the entire summer season. Much confusion, however, exists due to the lack of standardization of varieties. The behavior of the plant as affected by fertilization and pruning is little understood. The breeding of this plant has only begun. Already a spreading type has been introduced. During the past year projects were initiated with the object of determining the fertilizer needs, the best pruning practices, standardizing varieties, and breeding of superior varieties of the Crape Myrtle.

Factors Affecting Quality in Fruits

The Division of Horticulture, in cooperation with the Division of Chemistry, has undertaken a study of the composition of the Texas

Magnolia fig, the chief commercial variety grown in the State. Samples of figs from various localities of the Upper Gulf Coast region have already been analyzed. A study is also being made of the building up of the various chemical constituents of the fig. The fig orchard on the Main Station Horticultural Farm at College Station is being utilized for this purpose. The data will be interpreted and written up for publication during the fall months.

This work will be expanded during the coming year to include a study of the composition of citrus fruits and dates of the Lower Rio Grande Valley, and the Winter Garden region. The superior quality of Texas citrus fruits is already recognized, and it only remains to put this on a quantitative basis.

Canning, Preserving, Pickling, etc., of Horticultural Crops

Work in this field is at present confined to cooperation with local agencies. During the present season an attempt has been made to standardize methods for processing the jujube.

As soon as facilities permit, the pickling quality of Texas cucumbers will be studied. A prejudice seems to prevail in the minds of northern packers on this score, and a study of this kind is urgently needed to remove any such prejudice, which may prove unfounded.

Dehydration of Horticultural Crops

Large quantities of fruits and vegetables are a total loss to the State annually which could be profitably handled as dehydrated products. The Division of Horticulture has taken steps to work with local cooperators, as far as present facilities permit, in a preliminary study of methods for the dehydration of fruits and vegetables.

RANGE ANIMAL HUSBANDRY

Projects

1. Sheep Breeding Investigations (Study of the Inheritance of Fur Qualities of Karakul Sheep); State and local funds; J. L. Lush and J. M. Jones, leaders.
2. A Determination of the Relation of Skin Folds to Weight of Fleece on Rambouillet Sheep; State and local funds; J. M. Jones, J. L. Lush and W. H. Dameron, leaders.
3. Study of Type and Inheritance in Angora Goats; State and local funds; J. M. Jones, J. L. Lush and W. H. Dameron, leaders.
4. Inheritance of the Ridgling Characteristic in Goats; State and local funds; J. L. Lush and W. H. Dameron, leaders.
5. Inheritance in Brahman and Hereford Cattle; Adams, State and local funds; J. L. Lush, leader.
6. Feeding and Killing Qualities of Brahman, Shorthorn, Hereford, Brahman-Shorthorn, and Brahman-Hereford Calves; in cooperation with the Bureau of Animal Industry, and the King Ranch; State and cooperative funds; W. H. Black, for Bureau of Animal Industry, and J. L. Lush, for Station.
7. The Relation of Body Shape to Rate of Gain, to Dressing Per cent, and

to Value of the Dressed Meat in Beef Cattle; Purnell fund; J. L. Lush, leader.

8. Insects and Parasites Affecting Livestock; in cooperation with the Bureau of Entomology; State and cooperative funds; F. C. Bishopp and O. G. Babcock, for Bureau of Entomology, and J. M. Jones and W. H. Dameron, for Station, leaders.
9. A Study of the Adaptation of the Corriedale Sheep to Southwest Texas Conditions; in cooperation with the Bureau of Animal Industry; State and cooperative funds; J. M. Jones and W. H. Dameron, leaders.
10. An Economic Study of Shearing Sheep Once Versus Twice a Year; State and local funds; J. M. Jones, leader.
11. Determining Grades and Shrinkages of Representative Samples of Texas Wool and Mohair; State and local funds; J. M. Jones and S. P. Davis, leaders.
12. Relation of Age of Animal to Fineness of Wool and Mohair Fiber; Purnell fund; J. M. Jones and J. L. Lush, leaders.
13. Methods of Preparing Sorghum Roughages and Grains for Feeding to Fattening Calves and Lambs; State and local funds; J. M. Jones, J. L. Lush and R. E. Dickson, leaders.
14. Studies in the Growth of Mohair; in cooperation with the Bureau of Animal Industry, U. S. Department of Agriculture, and the Department of Animal Husbandry, A. and M. College of Texas; State and cooperative funds; A. K. Mackey (for College), D. A. Spencer and J. I. Hardy (for Bureau of Animal Industry), and J. M. Jones (for Station), leaders.
15. Value of Cottonseed Meal as a Feed for Work Horses and Mules; in cooperation with the Department of Animal Husbandry and the Department of Military Science, A. and M. College of Texas; R. H. Williams (for Department of Animal Husbandry), J. E. Sloan (for Department of Military Science), and Fred Hale (for Station), leaders; local funds.

Sheep Breeding Investigations

One project concerns Karakul sheep. The experimental work has been directed toward a moderate amount of inbreeding to the best rams, with the object of finding out how much the variation in the annual crop of Karakul pelts could be reduced by such breeding. Progress has been slow on account of difficulty in describing the skins objectively in terms that would have a definite meaning. Lack of profit in these sheep, due largely to the difficulty in selling profitably the skins in small lots, has made necessary plans for closing out this project.

Several matters of genetic interest, however, have been secured from this project. For example, an hereditary earlessness, wattles which are hereditary, a peculiar formation on the back of the ears which appears to be an abortive attempt at doubling of the ear, and several peculiarities of color, tail shape, and shape and tightness of curl in the pelts have been observed and studied.

The reports of the inheritance of these characters have either appeared or will appear in technical journals.

Type in Rambouillet Sheep

This study has been under way since 1922. The registered ewe flock has now been increased to approximately 230 head that are of breeding

age. A few of the least desirable and off-type kinds are culled from the flock during each year. The flock is being improved largely through line breeding at the present time and considerable improvement has been made over the original foundation flock of ewes.

There is an urgent need for an outstanding stud Rambouillet ram possessing the same line of breeding that has been used during the past several years to head the Ranch Station flock. The policy that is being practiced at the present time is to use rams of our own line of breeding until such time within the next year or two that a meritorious ram can be procured. It is believed that more rapid progress can be made through the use of Station-bred rams of known parentage in this study than to depend too strongly on the introduction of sires of unrelated blood lines.

Records covering each member of the registered flock are taken at regular designated periods. Important among these records are breeding weights, weights of ewes after lambing, birth weights of lambs, weaning weights of lambs, and skin fold records. Accurate records of fleece weights, length of staple, quality or fineness, clean yield of wool, in addition to several important body measurements, are also being recorded for each member of the registered flock.

The data covering the fleece records which were taken during the year bear out our previous tentative conclusion that representative B and C type Rambouillet ewes produce approximately the same amount of wool, clean content basis, during a 12-months growing period. During the year 1926-27, 87 C type Rambouillet ewes produced 3.34 pounds of clean wool as compared with 3.41 pounds produced by 37 B type ewes, or a difference of only .07 pound per head in favor of the B type group. The C type ewes produced a staple averaging 2.47 inches in length as compared with a length of 2.22 inches produced by the B type ewes. During the present year, 1927-28, 140 C type ewes produced fleeces with an average stable length of 2.3 inches. The average grease weight per fleece was 8.33 pounds, with a clean yield of 3.45 pounds, thus possessing a 58.6 per cent shrinkage. In the B type group 45 ewes produced fleeces with an average fiber length of 2.01 inches. The average grease weight per fleece was 9.25 pounds, with a clean yield of 3.54 pounds, showing a shrinkage of 61.8 per cent or 3.2 points higher than the fleeces from the C type ewes. While this study is still incomplete, the data so far accumulated indicate beyond any reasonable doubt that when B and C type Rambouillet sheep are handled under identical conditions on a given range the C type fleeces will show a shrinkage of at least two or three per cent under those produced by B type ewes.

Body and Fleece Weights of Rambouillet Sheep

A number of body- and fleece-weight records covering the registered Rambouillet ewe flock at the Ranch Experiment Station have been

prepared in tabulated form for the purpose of answering certain pertinent questions with reference to range-sheep production in Southwestern Texas.

The following table shows body weights and fleece weights for registered Rambouillet ewes produced on the Ranch Experiment Station, 1919-1928:

REGISTERED RAMBOUILLET EWES, LIVE WEIGHTS AND FLEECE WEIGHTS BY AGES FROM BIRTH TO NINE YEARS OF AGE, 1919-1928

Age	Number Weighed	*Average Body Weight Pounds	Number Sheared	Average Fleece Weight Pounds
At birth	206	9.8	.....	.....
At weaning	197	63.7	.....	.....
At 1 year	182	87.2	177	8.2
At 2 years	124	103.5	124	9.5
At 3 years	94	114.5	94	9.7
At 4 years	69	118.6	68	9.3
At 5 years	39	117.9	37	9.1
At 6 years	15	128.3	14	8.8
At 7 years	12	126.2	11	8.6
At 8 years	3	119.4	3	7.8
At 9 years	2	115.8	2	9.2

*Weighed about May 1st.

These records show that the period of growth or development of the Rambouillet sheep extends over several years. The fleece weights of sheep tend to remain relatively constant over the period from 2 to 5 years of age, and maximum fleece weights have been produced by sheep between the ages of 2 and 4 years.

The average fleece weight for 530 head (all ages) of Rambouillet ewes under observation in this study was 9.01 pounds in contrast to 8.5 pounds per head for sheep reported in the 1927 Annual Wool Review of the National Association of Wool Manufacturers for Texas.

A Study of Inheritance in Angora Goats

This study is being conducted for the purpose of securing some definite information regarding type and inheritance in Angora goats.

The leading American breeders of registered Angora goats are far from being in entire accord with respect to what types are most desirable.

There are several types of Angora goats, the most outstanding of which may be referred to as follows:

(a) The spiral ringlet type, which has frequently been referred to as being rather frail in constitution or undersized. The best goats of this type are noted for the fine quality of mohair that they produce; also their freedom from kemp.

(b) The flat type, which is generally regarded as a more robust animal, carrying more oil in the fleece than the ringlet type and generally, but not always, producing a coarser and heavier fleece.

(c) Such goats as do not qualify under either of the above groupings. This

class would include straight-haired, fluffy-fleeced Angoras, as well as blends between the ringlet and flat-lock types.

The pertinent question in the minds of the leading Angora goat breeders of America is: Which is the most desirable or profitable type to breed? It is customary today for mohair buyers to pay a higher price to the growers for kid hair than is paid for the hair produced by grown goats. Unfortunately, however, under the present marketing system in Texas and elsewhere throughout the United States, all mohair from grown goats is paid for (generally speaking) at the same price with little or no premium for quality. The growers recognize the unfairness of this practice, and as a result it has been very difficult to make any material progress in the direction of improving the quality of mohair produced. The range breeders, many of whom are engaged in the production of grade Angora goats, have in many instances lost sight of quality and have been breeding for quantity almost entirely.

This study was initiated for the purpose of developing two or more types of Angora goats in the Station flock for the purpose of gaining some definite, reliable information with reference to size of goat, type, character of mohair locks, quality of mohair, and freedom from kemp. Some outstanding Angora goats have already been developed since the establishment of the nucleus of the Angora goat flock in 1916. We do not yet, however, have the general uniformity which can only be attained through the use of the most desirable stud animals, which, unfortunately, have not always been at our command.

Angora Goat Body and Fleece Weights

A number of body- and fleece-weight records covering the registered Angora female flock at the Ranch Experiment Station have been tabulated for the purpose of answering some pertinent questions with reference to range Angora goat production in Southwestern Texas.

The following table shows body weights and fleece weights for registered Angora does produced on the Ranch Experiment Station, 1919-1928:

REGISTERED ANGORA GOATS, AVERAGE LIVE WEIGHTS AND FLEECE WEIGHTS BY AGES FROM BIRTH TO NINE YEARS OF AGE, 1919-1928

Age	Number Weighed	*Average Body Weight Pounds	Number Sheared	Average Fleece Weight Pounds
At birth	333	6.2	.....	.....
At weaning	322	36.7	.....	.....
At 1 year	276	48.0	335	4.5
At 2 years	250	58.5	247	6.9
At 3 years	178	67.3	190	7.1
At 4 years	129	72.5	129	7.1
At 5 years	78	76.3	76	6.9
At 6 years	51	77.1	51	6.5
At 7 years	30	75.7	30	6.3
At 8 years	29	88.3	19	5.5
At 9 years	9	82.8	9	4.6

*Weighed about May 1st.

These records show that the growth or development of the Angora goat extends over a period of several years. The fleece weights of Angora goats tend to remain relatively constant over the period from 2 to 5 years of age, and maximum fleece weights have been produced by Angora goats between the ages of 2 and 4 years.

The average weight for 1086 head (all ages) of Angora does was 6.16 pounds, in contrast to 4.44 pounds reported in the 1927 Annual Wool Review of the National Association of Wool Manufacturers as being the average annual production per head for Texas Angora goats. This bears out the importance of the production of heavy-shearing goats.

Inheritance in Brahman and Hereford Cattle

A detailed study was made of the changes in body measurements of steers during the fattening process. This has been published as Texas Station Bulletin No. 385, entitled "Changes in Body Measurements of Steers During Intensive Fattening." Data were available for 185 steers fed in nineteen different lots and concerned eight measurements taken on all steers and nine other measurements taken on some of the groups but not on others. In general, measurements of width increased most of all; circumference next; body length and depth next; and length of the long bones least of all. The soft fleshy parts of the body increase most rapidly, then the bones of the pelvic region, next the bones of the body, next the leg bones, and most slowly of all the bones of the head. Breed differences in the way shape changed during fattening were evident only in two measurements—paunch girth and flank girth. Differences here were so slight that they could be demonstrated only in group averages and hence genetic analysis of the hereditary basis of those differences seem to be so difficult as to be impossible on the present scale of this investigation.

A study of the accuracy of fractions of blood in describing the genetic constitution of individual grade animals showed that such expressions are fairly accurate where large numbers of genetic factors are different in the breeds or strains crossed. Such expressions, however, are probably not accurate enough to justify the use of fractions of blood much smaller than one-sixteenth. This study was published in the Journal of Heredity, Vol. XVII, No. 8, August, 1927, under the title "Percentage of Blood, and Mendelism," by J. L. Lush.

No steers were fed out during this year in connection with this project, but the seventh crop of calves was kept on pasture at the Ranch Experiment Station, and the eighth crop of first-cross and fifth crop of back-cross calves were dropped there and, together with the preceding year's calves, will probably be fed out during the coming year.

The advantages of a small amount of Brahman blood in cattle are increased ability to thrive in hot climates under conditions of scanty and coarse feed, greater freedom from insect annoyance, a high degree of resistance to splenetic fever, and high-dressing percentages. The disadvantages are: first, their wild and nervous dispositions; second, their

conformation, which is not considered desirable by most of the butcher trade which uses high-class meat; third, their probably greater susceptibility to sudden and severe cold storms. Just how these various factors will balance up is not yet clear, but it is evident that the balance will be more favorable to Brahman blood far in the south and at the low altitudes than it is in the central and northern parts of the State or in highland regions which have good pastures. The feeder trade is not at present favorably inclined toward Brahman cattle of any age, but the packers buy them readily, showing no discrimination at all against them as calves, especially if fat. With increasing age and weight a discrimination against the Brahman type of carcass occurs and becomes greater, frequently amounting to between 50 cents and $1.00 per hundred pounds live weight on three- and four-year-old steers. This discrimination is founded on the opinions and experience of the average retail butcher and is not uniform with all butchers, nor in all regions. Whether it is justified by any intrinsically undesirable characteristic of the meat, such as toughness or coarseness, is still uncertain.

The Inheritance of the Ridgling Characteristic in Angora Goats

This year's work has confirmed the work of previous years in showing beyond all reasonable doubt that cryptorchidism is an inherited defect in Angora goats. Three different ridgling sires were used this year. One sired eight ridglings and nine normal sons. The second sired six ridglings and eleven normal sons. The third sired four ridglings and fourteen normal sons. The plans for the coming year are to line-breed strongly to the first buck in the hope of so purifying the hereditary basis for this defect that a flock can be built up which will produce no males except ridglings. When such a flock is built up, suitable crosses can be made to determine the exact manner of the inheritance of this defect. When that is learned, we can determine the best procedure for eradicating this defect entirely from other flocks. For the last four seasons, 29.5 per cent of all males (281 head) born in the flock where ridgling sires were used have been ridglings as compared with 6.3 per cent of all males (300 head) born in the flock where no ridgling sires have ever been used.

The work so far has clearly demonstrated that it is unwise for the breeder ever to use ridgling sires. No bad results may be visible in the first or second kid crop, but ridglings are certain to occur in larger numbers in successive generations. Whether it is also wise to cull out of the stud flock does which have produced ridgling kids is not yet certain. This should be done if the stud does are only of ordinary merit, but if the does are of outstanding merit otherwise, we do not yet know enough about the inheritance of this defect to say whether such a doe should be at once culled from the stud flock merely because she has produced a ridgling son.

Feeding and Killing Qualities of Calves

This is a cooperative project with the United States Department of Agriculture and with the King Ranch. This experiment was practically completed the previous year and the only work this year consisted of finding out the rates of gains made by several lots in the feeding pens at the King Ranch. No other data were collected. These data, together with those from the previous three years' work, are now being prepared for publication, and this project is regarded as completed.

The Relation of Body Shape to Rate of Gain, to Dressing Per cent, and to Value of the Dressed Meat in Beef Cattle

Data from seventeen lots of steers fed out at Substation No. 7, Spur, Texas, during the last five years form the basis of this project. The calculations have been very much advanced during the past year. The changes of body shape during fattening were studied and published in Texas Station Bulletin No. 385, entitled "Changes in Body Measurements of Steers During Intensive Fattening." Because it was technical in nature, this bulletin was not distributed to a very large mailing list, but it may be had free of charge upon request. The other aspects of this problem have not yet been prepared for publication.

A study of the accuracy of cattle weights, on which rests much of the interpretation of these data, was made and published in the Journal of Agricultural Research, Vol. 36, No. 6, pp. 551-580, March 15, 1928, entitled "The Accuracy of Cattle Weights." In general this study showed that under conditions prevailing in experimental feed-lots, a single weight of a cow or steer was within 6 to 8 pounds of the true weight about half the time. These variations in weight are no doubt due almost entirely to variations in the amount of food or water just ingested or in the amount of urine and feces just voided,—in other words, in the contents of the digestive and excretory organs. On account of this intrinsic variation of cattle weights, experimental data involving cattle weights must be interpreted with care. Weighing for three days instead of one day alone is one precaution taken to guard against undue influence of variation in weights.

Studies on the accuracy of body measurements of cattle seem to indicate that most measurements are less accurate than weights. This is especially true of measurements of soft parts, such as chest width and loin width, or measurements involving movable joints, as in the case of body length.

Methods of Preparing Sorghum Roughage and Grains for Feeding to Fattening Lambs and Calves

Seventy-five wether lambs were fed through a cooperative agreement on the sheep farm of the Department of Animal Husbandry of the College at College Station in a study of methods of preparing sorghum grains for feeding fattening lambs. The lambs were fed 84 days from

December 9, 1927, to March 2, 1928. There were 25 lambs in each of three lots. All of the lambs were high-grade Rambouillets, and were very uniform in type and weight, averaging 61 pounds at the beginning of the trial.

The lambs in Lot I fed whole threshed milo and chopped alfalfa hay made an average daily gain of .259 pounds. They required 4.11 pounds of grain and 4.31 pounds of hay for each pound of gain. The lambs in Lot II were fed whole threshed milo, cottonseed cake screenings, and chopped alfalfa hay. These made an average daily gain of .285 pound. In this lot, 3.76 pounds of milo, .42 pounds of cottonseed cake screenings, and 3.97 pounds of hay were required for each pound of gain. The lambs in Lot III were fed the same as those in Lot II, except that ground threshed milo replaced whole threshed milo. The lambs in this lot made an average daily gain of .304 pounds. The lambs in this lot required 3.52 pounds of the ground threshed milo, .39 pound of cottonseed cake screenings, and 3.71 pounds of alfalfa hay to produce each pound of gain.

Value of Cottonseed Meal as a Feed for Work Horses and Mules

This project was approved September 19, 1927, and is cooperative with the Animal Husbandry and Military Departments of the Texas A. & M. College. The object of this project is fourfold, as follows:

1. To determine the influence of cottonseed meal on the general health and spirit when included in a ration for work horses.
2. To determine the influence of cottonseed meal on the ability to withstand work and heat when included in a ration for work horses.
3. To make practical observations on palatability, economy, and important physiological properties of cottonseed meal as a feed for work horses.
4. To determine the value of cottonseed meal as a feed for brood mares and growing colts.

In October, 1927, twenty head of horses and mules belonging to the Animal Husbandry Department of the College were divided into three groups for study as to the use of cottonseed meal as a part of their ration. A basal mixture of concentrates containing 20 per cent rice bran and 80 per cent ground milo was fed to the animals in Lot I, along with carbonaceous roughages consisting chiefly of prairie and Sudan hay. The animals in Lot II were given the same roughages and one pound of cottonseed meal replaced a like weight of the basal concentrate mixture. In Lot III each animal was fed two pounds of cottonseed meal and the concentrates reduced by two pounds per head daily. The amount of concentrates varied according to the age of the animal, the size of the animal, and the work it was doing. The work stock were fed one pound of the concentrates per one hundred pounds live weight, and the young animals were fed enough to keep them in good breeding condition.

The investigation has been under way for only one year, and does not justify the drawing of definite conclusions. The animals ate the

meal with as great relish as rations with no cottonseed meal. No experimental animals died, became blind, lost their hair, or suffered more from colic or heat than similar stock given rations without cottonseed meal.

A weaning filly weighing 483 pounds when placed on the test has eaten two pounds of cottonseed meal daily for a full year, and has not missed a meal and has made good growth and gains. Colts, brood mares, and work mares and mules fed cottonseed meal have done as well as similar animals not getting the meal.

It is planned to continue this investigation another year, to study the cumulative results from feeding cottonseed meal to horses and mules. The present plan is to utilize some forty head of the Cavalry and Artillery horses belonging to the Military Department in the test during the ensuing year.

Insects and Parasites Affecting Live Stock

This project is being conducted in cooperation with the Bureau of Entomology, United States Department of Agriculture, and is divided into three parts, as follows:

Subproject No. 118-A, The Screw Worm and the Wool Maggot.
Subproject No. 118-B, The Goat Louse.
Subproject No. 118-C, A Study of the Sheep Scab, the Sheep Scab Mite, Its Life History and Eradication.

The Screw Worm and the Wool Maggot: Cooperative studies covering the screw-worm blow-fly and the wool-maggot blow-fly were begun in 1920. Fly trapping has proved to be very effective and considerable information has been secured with reference to types of fly traps best adapted to the purpose of catching blow flies. Furthermore, a great deal of consideration has been given to the matter of baits, including frequency of re-baiting the traps. The effectiveness of fly repellants and worm or maggot killers are also being studied.

The Goat Louse: A number of dip preparations are being tested on Angora goats infested with lice, with a view of preparing a dipping solution that will be effective in eradicating goat lice. The life history of the several species of goat lice is also being studied.

A Study of the Sheep Scab, the Sheep-Scab Mite, Its Life History and Eradication: This study, which was begun in 1924, is being closed out and the data are being prepared for publication.

A Study of the Adaptation of the Corriedale Sheep to Southwest Texas Conditions

This study was started in 1920, in cooperation with the Bureau of Animal Industry, United States Department of Agriculture, for the purpose of determining whether or not this breed of sheep might show any advantages over the Rambouillet handled under range conditions on the Ranch Experiment Station in Southwestern Texas. Only eight head of registered Corriedale ewes were available at the beginning of

this trial. General data being recorded in connection with this study have included birth weights, weaning weights, breeding weights, weights at one year, and annually thereafter, fleece weights, grade of wool, length of staple, shrinkage of individual fleeces during scouring, aside from several important body measurements which are taken annually. Thirty-six registered Corriedale ewes were bred in the fall of 1927 in comparison with 176 registered Rambouillet ewes. Several of the ewes and rams carried 6-months fleeces during the year 1927-28 and were not included in this study.

During the year 1927-28 only one Rambouillet ram carried a fleece over the twelve-months period. The grease weight of this fleece was 14.55 pounds, with a clean yield of 5.5 pounds, as compared with an average grease-fleece weight of 8.88 pounds for two Corriedale rams' fleeces which yielded 4.2 pounds per fleece scoured, or 1.3 pounds less than the fleece from the Rambouillet ram. Thirty-four Rambouillet yearling ewes produced an average grease-fleece weight of 7.51 pounds, or 3.5 pounds scoured, as compared with an average greece-fleece weight of 7.38 pounds, or 3.48 pounds scoured, produced by two Corriedale yearling ewes. One hundred and fifty-one aged Rambouillet ewes produced an average of 8.79 pounds grease wool per head, or 3.56 pounds scoured, as compared with an average of 7.73 pounds grease weight per head, or 3.95 pounds scoured, produced by thirty-six aged Corriedale ewes. The Corriedale ewes produced approximately .5 pound more clean or scoured wool per head than did the Rambouillet ewes during the year 1927-28.

Weight records taken of Rambouillet and Corriedale sheep in the study show that the latter breed does not attain as heavy a weight as does the Rambouillet under range conditions in Southwest Texas. In the spring of 1928, three registered Corriedale rams averaged 134.8 pounds as compared with an average weight of 167 pounds for 29 aged Rambouillet rams. Thirty-five aged Corriedale ewes averaged 94.4 pounds as compared with an average of 112 pounds for 162 aged Rambouillet ewes. Two Corriedale yearling ewes averaged 81 pounds as compared with an average of 83.5 pounds made by 51 Rambouillet yearling ewes. Fifteen Corriedale ewe lambs averaged 35.7 pounds as compared with an average weight of 48 pounds made by 86 Rambouillet ewe lambs. The average birth weights of 18 Corriedale ewe lambs in the spring of 1928 was 9.53 pounds as compared with an average of 9.86 pounds for 92 Rambouillet ewe lambs; and 10.44 pounds for 16 Corriedale ram lambs as compared with 10.45 pounds for 77 Rambouillet ram lambs.

The following table shows the comparative lambing records of the Rambouillet and Corriedale groups of ewes during the years 1921 to 1928, inclusive. It will be observed that the lambing percentage for the respective groups was practically the same for the years 1927 and 1928.

LAMBING RECORD OF REGISTERED RAMBOUILLET AND CORRIEDALE FLOCKS, 1921-1928, AT THE RANCH EXPERIMENT STATION

Year	Rambouillet			Corriedale		
	Number Ewes	Number Lambs	Per Cent Lamb Crop	Number Ewes	Number Lambs	Per Cent Lamb Crop
Spring 1921	26	26	100.00	8	8	100.00
Spring 1922	28	20	71.43	8	3	37.50
Spring 1923	69	65	94.20	12	12	100.00
Spring 1924	75	67	89.33	13	14	107.69
Spring 1925	94	78	82.98	19	20	105.26
Spring 1926	119	81	68.07	23	21	91.30
Spring 1927	143	107	74.83	31	23	74.19
Spring 1928	176	170	96.59	36	35	97.22

Shearing Sheep Once Versus Twice a Year

In the fall of 1920, the Texas Agricultural Experiment Station began a shearing test at the Ranch Experiment Station for the purpose of securing answers to the following questions:

1. Do sheep sheared twice a year produce more wool annually than those sheared at 12-months' intervals?
2. Do ewes sheared twice a year produce a larger lamb crop than those sheared once a year?

A representative flock of high-grade Rambouillet sheep has furnished the material for this study, and more than 1,300 individual shearings have been completed to date in the groups sheared at 12-months and about the same number of 6-months intervals. The average difference to date, including all groups and classes of sheep that have been in the test since its inception, is 0.78 pound of wool per head per annum in favor of the groups sheared twice a year.

Twenty-seven aged wethers in the group sheared twice a year during the period 1920-23 produced on an average 1.56 pounds more wool per head annually than 24 head which carried 12 months' fleeces. During the period 1920-24, 84 yearling wethers sheared twice a year produced on an average 0.45 pound more wool per head per annum than 82 head that carried 12 months' fleeces. In the aged ewe class, which is the largest group that has been studied in the test, 900 head shared twice a year produced on an average 0.85 pound more wool per head per annum than a group of 860 similar ewes which carried 12 months fleeces. In the yearling ewe class, 300 head sheared twice a year have produced 0.74 pound more wool per head than a similar group that carried 12 months' fleeces.

The percentage of lambs dropped by 889 aged ewes sheared once a year was 93 per cent and by 903 aged ewes sheared twice a year during the eight-year period, 1920-28, was 91 per cent, Three hundred yearling ewes (those bred at 18 months) carrying 12 month's fleeces showed an average lamb production of 62 per cent as compared with 65 per cent in a group of 300 head sheared twice a year.

There was an average death loss of 2.9 per cent in the aged ewe class

carrying 12 months' fleeces as compared with a loss of 1.8 per cent in the corresponding group sheared at six months' intervals. In the yearling ewe class there was a death loss of 2.7 per cent in the group sheared once a year as compared with 1.3 per cent loss in the corresponding group sheared twice a year.

Although the sheep sheared twice a year over the eight-year period produced approximately 0.75 pound more mool per head annually than those sheared only once in 12 months, no material advantage is gained in shearing twice a year. Shearing twice a year entails twice the cost of shearing at 12 months' intervals. Furthermore, the fall shearing season comes at a time when the blow-fly pest is very active, and unless careful attention is given the flock after the fall shearing heavy losses are likely to result. Fine staple wool usually commands a sufficient premium over the fine clothing wool to more than offset the increased weight produced, and over the fourteen years, 1911 to 1925, this premium amounted to 19 to 25 cents a pound scoured basis. The current year has been the exception and during recent months Texas fine clothing wools have sold almost on a par with the fine staple kind.

Shearing either once or twice a year apparently has little or no influence on the ensuing year's lamb crop. Furthermore, there was but a slight difference in the death losses between the two groups.

Determining Grades and Shrinkages of Texas Wool and Mohair

This project has for its primary object the accumulation of a sufficient amount of wool and mohair data which would give the wool and mohair growers of Texas more definite information covering the grades and shrinkages of the wool and mohair that they are producing.

In addition to a number of individual fleeces of wool and mohair produced by the flocks at the Ranch Experimental Station which are used in this study, an endeavor is made to get representative samples from ranchmen operating in different parts of the State. This is necessary on account of the wide variation in soil and climatic conditions in the different areas of this vast territory.

During this year, 158 range wool tests were made in addition to 565 individual scouring tests on individual wool fleeces produced on the Ranch Experiment Station. Thirty-eight range mohair tests were made, aside from 302 individual mohair fleeces produced by the Ranch Experiment Station.

The Wool and Mohair Scouring Plant, which was established at the Agricultural and Mechanical College of Texas in 1919 as a result of the active interest taken in wool and mohair shrinkages by the Sheep and Goat Raisers Association of Texas, has proved very helpful to the sheep raisers of the State. Active operation of the plant was begun in 1921, and during the ensuing eight years more than 48,000 pounds of wool, showing an average shrinkage of 60.5 per cent, have been scoured for wool growers of Texas, aside from thousands of pounds from the Ranch Station flock which was scoured for experimental

purposes. Valuable data have also been secured from scouring mohair samples.

During the years 1918 and 1919, the estimated shrinkage of Texas wools was 67 per cent, according to the Annual Wool Review published by the National Association of Wool Manufacturers. In 1927 the same publication estimated the shrinkage of Texas wool at 61 per cent, or 6 per cent lower than in 1918 and 1919, before our wool-scouring records were available. The wool growers of Texas have attributed the lower estimated shrinkage to the results secured at the Wool Scouring Plant.

Estimating the 35,000,000 pounds of Texas wool as having a shrinkage of 61 per cent, the total amount of clean wool would be 13,650,000 pounds. An error of one per cent in estimating the shrinkage on such a basis would result in a gain or loss of 350,000 pounds of clean wool to the growers, worth in recent years about $1.00 a pound. Furthermore, the scouring records at the Wool Scouring Plant have revealed considerable regional variations which had hitherto not been apparent. For instance, Val Verde County, with approximately 400,000 sheep, producing around eight pounds of wool per head, or 3,200,000 pounds annually for the County, has sent more than 17,000 pounds of samples for scouring, the average shrinkage of which was only 58.35 per cent. These scouring tests have had their influence in lowering the estimated shrinkage of the wool produced in Val Verde County approximately five per cent, which means for that county alone a saving of about $160,000.00 annually, based on a price of $1.00 a pound for clean wool. When other sections of the State patronize the plant as extensively as Val Verde County, similar advantages may be revealed in these sections also.

When the Scouring Plant was established it became necessary to make scientific studies to develop reliable methods of drawing representative samples. In the case of wool in particular, it was found that some Texas fine wool fleeces have a range in shrinkage from as low as 45 per cent to as high as 75 per cent. The results of these studies of various methods of sampling fleeces have shown that 25 entire wool fleeces selected impartially at the shearing pens will have a shrinkage that is sure to be within 2 per cent of the shrinkage value of the wool from the entire flock and one-half of such 25-fleece samples will have a shrinkage within two-thirds of one per cent of that of the entire flock. Samples that are not representative are not only worthless, but may be deceiving to the buyers and sellers.

During the year a total of 8,260.9 pounds of wool and 1,274 pounds of mohair were graded and scoured by the Wool and Mohair Scouring Plant of the Texas Agricultural Experiment Station.

Relation of Age of Animal to Fineness of Wool and Mohair Fiber

This study is being made for the purpose of determining, if possible, just how much influence the age of the animal exerts upon the fineness

of the fiber produced. This study has included the diameter measurement of 100 fibers annually from shoulder, side, and thigh samples from a large number of registered Rambouillet sheep and Angora goats at the Ranch Experiment Station. The Brown and Sharpe Micrometer Caliper, measuring to one ten-thousandth of an inch, has been used in this study. Analyses of these records are now under way, and it is hoped that a summary of the results covering the five-year period, 1924-1928, may be completed for publication during next year.

Studies in the Growth of Mohair

This project is being carried in cooperation with the Animal Husbandry Department of the A. & M. College of Texas, and the United States Department of Agriculture. The object of this project is to determine the normal rate of growth and establish the growth curve for mohair as the foundation for "Studies in the Growth of Mohair" as related to various methods of breeding, feeding, and management, and supplements other mohair studies, such as those being made by the United States Department of Agriculture and also the study of "Type and Inheritance in Angora Goats," being conducted at the Ranch Experiment Station.

The study to determine the rate of mohair growth is being made for the present only on the Animal Husbandry flock. A small area on the shoulder of each of seventeen grade Angora goats is clipped every twenty-eight days. These clippings are forwarded to the Bureau of Animal Industry, United States Department of Agriculture for final length measurements.

As a part of this study, representative mohair fleeces from both the Department of Animal Husbandry and the Ranch Experiment Station flocks are being submitted to the Sanford Mills, Sanford, Maine, where they are carefully graded in the presence of Dr. J. I. Hardy, Fiber Specialist of the Bureau of Animal Industry, United States Department of Agriculture. In this study, fleeces from certain designated Angora goats are being graded through consecutive shearings, and it is hoped that some more definite information will thus be obtained with reference to the quality and general desirability of mohair fleeces from the first kid fleeces until the animal has reached the age of six to eight years.

An insufficient amount of work in the scouring of mohair fleeces has been done to justify definite conclusions. The range of shrinkage in mohair fleeces scoured at the Wool and Mohair Scouring Plant varies from as low as 1.5 per cent to as high as 30 per cent, with an average of probably about 15 per cent. Many Texas Angora goat breeders are striving to produce oily or heavy shrinking fleeces in order to increase the total weight of fleece in the unscoured condition. Through a more liberal patronage of the Wool and Mohair Scouring Plant on the part of Texas Angora goat breeders it will be possible to determine definitely whether or not any distinct advantage is gained in the production of

the heavy-shrinkage fleeces over those having a shrinkage ranging around 15 per cent.

ENTOMOLOGY

Projects

1. A Study of the Ingestion of Poison by the Cotton Boll Weevil; Adams fund; H. J. Reinhard, leader.
2. Life History of the Cotton Flea Hopper (*Psallus seriatus* Reut.), and Its Control; State funds; F. L. Thomas and H. J. Reinhard, leaders.
3. Boll Weevil Control by the Use of Airplanes; State funds; F. L. Thomas, leader.
4. Pink Boll Worm Investigations; in cooperation with the Bureau of Entomology, U. S. Department of Agriculture; State and cooperative funds; F. A. Fenton, for Bureau of Entomology; F. L. Thomas and W. L. Owen, Jr., for Station, leaders.
5. Control of the Cotton Boll Worm; State funds; R. K. Fletcher, leader.
6. Hibernation of the Cotton Flea Hopper and the Boll Weevil; State funds; H. J. Reinhard, leader.
7. Miscellaneous Insect Investigations; Control of Ants on Citrus Trees; State Funds; F. L. Thomas and W. H. Friend, leaders. See report of Substation No. 15.
8. Control of Scale Insects on Citrus; State funds; F. L. Thomas, W. H. Friend, and S. W. Clark, leaders. See report of Substation No. 15.
9. Sulphur and Sulphur Compounds as Insectides; F. L. Thomas, leader.
10. Control of Plant Lice on Truck Crops in the Gulf Coastal Region of Texas; State and cooperative (with the Freeport Sulphur Company) funds; F. M. Hull, leader.
11. Insect Pests of Corn and Grain Sorghums while in Storage; State funds; F. L. Thomas and W. L. Owen, Jr., leaders.
12. Foulbrood Inspection; State funds; S. E. McGregor, Jr., leader.
13. Life History and Methods of Controlling the Pecan Twig Girdler; cooperative (with the School of Agriculture) funds; S. W. Bilsing, leader.
14. Rodent Control Work in Texas; in cooperation with the Extension Service of the A. and M. College of Texas and the Bureau of Biological Survey, U. S. Department of Agriculture; Leaders: L. C. Whitehead, for Bureau of Biological Survey, County Agents for Extension Service, and F. L. Thomas for Station.

Ingestion of Poison by the Boll Weevil

Work on this project during the past year has been directed toward an attempt to evaluate the different portions of the cotton plant according to the relative importance in killing boll weevils after an application of calcium arsenate dust. The experiments, in which more than 1,500 weevils were used, show that the various portions of the cotton plant after a field application of dust have the following relative importance in killing boll weevils for the five days following an application: Stems 2.2; fruit (squares and bolls) 13.2; leaves 84.6. Stated in other words, the poison on the fruit is six times more important than that on the stems, and the poison which adheres to the leaves is six times more important than that which remains on the fruit. These results were obtained in experiments where fifty weevils were used per plant during July and August.

Life History of the Cotton Flea Hopper and Its Control

From the information gained under the project on Hibernation, it was not expected that the cotton flea hopper would prove to be important among the cotton insects of the year. This proved to be the case, and aside from keeping a close watch for possible occurrence, nothing has been done under this project during the year. A few widely scattered and in some cases doubtful reports were received of instances of early injury. Mid-summer infestations have been observed in a few places and usually have occurred on young cotton. The source of these infestations is not clearly understood.

Pink Boll Worm Investigations

Prior to 1927, investigations of the pink boll worm were conducted in Mexico by the United States Department of Agriculture. The occurrence for several years of this insect along the Rio Grande in the Big Bend section has been a constant menace to the cotton-growing area in the United States, and the need for information on all phases of the pink boll worm in this State has been realized. For the first time, 1927-1928, the Texas Agricultural Experiment Station has been in position to attempt studies of this pest in the distant location of the Big Bend. A cooperative agreement has been arranged with the Bureau of Entomology of the United States Department of Agriculture, and during the past year a broad and intensive program has been outlined and is being diligently carried out.

A laboratory for conducting the biological work was established at Presidio, and during the summer of 1928, five men from the Experiment Station were engaged in various phases of the pink boll worm investigations. In addition to the biological studies, trap plantings, flight studies, host plant surveys, and experiments on clean-up work have been undertaken.

One of the most important phases of the present problem has to do with the prevention of the spread from quarantine areas to those not under restriction, as well as with the policy of the establishment of non-cotton zones. Whether or not the moths fly or can be carried long distances by air currents, under what conditions this occurs, and from what centers the species spreads, is of paramount importance. It is hoped that these questions can be answered when records are obtained from a series of interrelated experiments in connection with trap-planting or isolated plantings, flight studies, and host-plant surveys.

Seventeen isolated plantings of cotton and two of okra, six to sixty-five miles from the nearest cotton fields, were made within the quarantined area and extend from Van Horn on the west to Terrell County on the east and north to Ector County, which is the western limit of cotton production without irrigation. Similar plantings have been made in the past in Mexico and also in the Big Bend and under certain conditions the plants became infested. The plan of locating the plats over

a wide area was for the purpose of determining where and in what direction flight occurs. This work has been supplemented by weekly records of infestation in cotton along the Rio Grande and by airplane collections of moths.

In connection with the host-plant survey, an experimental garden is being maintained at Presidio. Thurberia, cotton, several varieties of okra, hollyhock, and several species of wild and cultivated malvaceous plants of the section are being studied with reference to their development and fruiting and to determine by experiment and otherwise whether or not they can be infested. Some scouting has also been done to determine the range and location of these plants, so that in case the species is infested in the garden at Presidio its range will be known.

Experiments to determine the best methods to use in field clean-up operations indicate that a very high mortality resulted from winter irrigation following winter burial of infested material, but that winter irrigation or winter burial alone was not effective. In this connection it is also important to know where the larvae are found during the winter. In the determination of this point, 96 per cent of the overwintering larvae were found either in the forms on the cotton plants or in the surface trash on the ground and four per cent in the soil or on the tap roots of the plants.

Emergence of moths from bolls on or in the soil at Castolon, in Brewster County, extended from March 27 to July 2, 1928, the heaviest emergence occurring from April 14 to 30.

Control of the Cotton Boll Worm

Active work was begun on this study September, 1927. This insect has not been controlled by the usual measures recommended for poisoning the boll weevil. Instead, in some instances it has even been claimed that the use of calcium arsenate dust has caused an increase in the boll worm infestation.

Since the cotton boll worm is found on almost every farm and causes considerable injury in Texas, a thorough and intensive investigation of this insect was started in the fall of 1927. The work has been carried on during 1928 in the vicinity of Taylor, in Williamson County, near McKinney, in Collin County, at Spur, in Dickens County, in Burleson County, and at College Station. Extensive observations have been made and notes taken on the following:

Seasonal history of the insect.
Infestation in corn, cotton, and other host plants.
Occurrence of parasites.
Relation of soil conditions to emergence of moths.
Use of attractants for catching moths.
Influence of calcium arsenate on the infestation.
Condition of cotton with reference to nectar secretion in relation to oviposition.

The main object of this work has been to determine the factors pro-

ducing variations in the infestation of cotton which sometimes occur within comparatively narrow limits.

While the data obtained have not yet been thoroughly studied, the indications are that honey-dew secreted by cotton lice is attractive to the moths when laying eggs. Evidence of this has appeared in the heavier infestation which occurred when plant lice were abundant and also in the larger numbers of moths trapped where sweetened liquids were used.

Hibernation Studies

The results of hibernation studies of the cotton flea hopper for the period from 1925 to 1927 appear in Texas Station Bulletin No. 377, entitled, "Hibernation of the Cotton Flea Hopper." In general, these results show that early emergence with reference to the time when cotton is planted indicates a light infestation of the current crop. In 1928, the emergence of the cotton flea hopper was light, which, coupled with the further fact that a large percentage of the insects which emerged had hatched before the cotton came up, indicated a light infestation, which subsequently proved to be the case except for isolated areas.

The boll weevil survival in 1928 for College Station was .42 per cent, the smallest ever recorded here, and the period of emergence was from March 1 to April 17. This small emergence and its short period of duration indicated light injury, which proved to be the case in general in 1928.

Control of Ants on Citrus Trees

Tests conducted in the fall of 1927 demonstrated that ants affecting citrus trees can be controlled by disturbing the nest and dusting with calcium cyanide dust or spraying with carbon bisulphide emulsion.

Sulphur and Sulphur Compounds as Insecticides

Practically all work in connection with this project has been carried on in Galveston County, where the plant lice investigations are being conducted, and at Texas Substation No. 15, Weslaco, in the Lower Rio Grande Valley where the citrus and truck crop insects are abundant.

Promising results have been obtained in the use of lime-sulphur or sulphur wash in controlling fire ants, *Solenopsis geminata,* on the trunks of young citrus trees. For several years the tomato suck fly has been a problem in Southwest Texas. Encouraging results in the control of this insect have been obtained from the use of dry sulphur or a sulphur-napthalene mixture.

Experiments in controlling the bean leaf hopper with sulphur dust are to be continued.

The value of sulphur dust in controlling the cotton flea hopper is brought out in Texas Station Bulletin No. 380, entitled "Investigations on Control of the Cotton Flea Hopper in 1927," which was issued May, 1928.

Insect Pests of Corn and Grain Sorghums While in Storage

No work was done under this project during the year.

Foulbrood Inspection

During the year 1927-28, a total of 34,761 colonies of bees belonging to 511 beekeepers were examined. American Foulbrood was found in 548 colonies, or 1.5 per cent of the total number. Practically three months were devoted to the inspection of colonies belonging to the 58 queen breeders and package bee shippers who made application.

Life History and Methods of Controlling the Pecan Twig Girdler

No work was carried on during the year under this specific subject. Some work, however, was conducted on the Life History and Control of the Pecan Nut Case Bearer, experiments being conducted in an orchard of about 30 acres at Simonton, in Fort Bend County. Observations have been made on the use of whale oil soap as a sticker for the sprays and also on the comparative control and relative cost of spraying and dusting.

Rodent Control Work in Texas

Under this project, which was begun September 1, 1927, provision was made for cooperative action between the Agricultural and Mechanical College of Texas and the Bureau of Biological Survey of the United States Department of Agriculture, in destroying injurious rodents; to provide for research study related to rodent control as may seem desirable to the cooperating parties; and to demonstrate to farmers, ranchmen, and others interested effective methods of destroying rodent pests, and protecting their pastures, growing crops, and stored grain from destruction by these pests. Both the Agricultural Experiment Station and the Extension Service represented the College in this cooperative work.

Mr. L. C. Whitehead, Bureau of Biological Survey, leader of the project, has made the following report of the work done:

Organized rat campaigns were conducted in 34 counties, and a total of 3,690,528 rat tails were collected. The counties cooperated by offering over $6,000.00 in prizes to the school children for the collection of rat tails. In addition, 22,200 pounds of poison were exposed in cooperative campaigns, and nine tons of poisoned grain in field rat control in Jefferson and Galveston Counties.

In gopher control there was organized work in poisoning and trapping on 33,170 acres in the El Paso Valley, at 6½ cents an acre for cost of operation. More than 3,700 quarts of bait were exposed in poisoning and 1,227 gophers were trapped. Community gopher control was practiced in 14 counties of East and South Texas. In Hopkins County 17,080 gophers were caught.

In the work of controlling prairie dogs, 265,962 acres were treated with poison grain, in 49 counties. County Commissioners Courts, and

Chambers of Commerce cooperated and were assisted by the County Agricultural Agents and field men.

Control of Plant Lice on Truck Crops in the Gulf Coastal Region of Texas

The plant lice problem is a serious one in the humid part of the Gulf Coastal section of Texas where winter truck crops are grown, particularly in Galveston and Brazoria Counties. The damage done to the leafy truck crops, such as mustard, turnips, and radishes justified the employment of an entomologist to study the control of this pest. This work was under the immediate supervision of Mr. F. M. Hull, Entomologist, with headquarters at Substation No. 3, Angleton, and was begun on September 1, 1927. The major part of the experimental work was done in Galveston County, the species of louse involved being the turnip louse, *Aphis pseudobrassicae,* Davis.

The first experiment on the control of the turnip louse carried on was a test of spray materials. Nicotine sulphate and Destruxol were used on heavily infested mustard and turnips which were about half grown. The average per cent of kill was about 50. Due to the cost of the material, the difficulty of application, and the incomplete kill obtained, it was concluded that these sprays were not suitable for the control of plant lice in this section.

A four per cent nicotine dust was tried with a hand duster under almost ideal conditions. The average kill was 84 per cent. Under less favorable conditions the average kill was reduced to 40 per cent. The cost of the material and the low kill made the use of nicotine dust for the control of plant lice in this section undesirable. It is almost impossible to reach all the lice with the dust, and the usually windy weather and low temperatures prevailing at that time of the year make this form of treatment ineffective for this section of the State.

Since the results obtained from the spraying and dusting experiments were not satisfactory, it was necessary to search for a more suitable material or method of combating the lice. Fumigation with hydrogen cyanide was tried. All the lice were reached, and while not all were killed in the first experiments, later tests gave a complete kill. This is a cheap gas, and it remained to determine the amount of gas to use for a given area, the length of time of application, and a suitable apparatus for confining the gas. Therefore, experiments with various covers for confining gases for fumigation of plants in the control of plant lice were carried on. A frame constructed of beaverboard proved to be too costly and too heavy and cumbersome. Canvas-covered frames, waterproofed with lead paint, were found better suited for this work than the first type of frame tried out. A frame covered with a good type of durable paper was found to be cheaper and lighter than the first two frames tried out and was very desirable. Waterproofed canvas with no frames was tried out, but since the amount of cyanogas to use could not be properly determined when this type of cover was used, it was not successful. A series of tests with Cyanogen on mustard shows that it is easily possible

to injure or kill the plants by an application of an overdose of the fumigant.

The burning of nicotine paper in a confined space was tested for the control of plant lice. No kill was effected in the one experiment carried out.

A large number of Syrphus fly maggots were found on the leaves of plants heavily infested with plant lice. These larvae feed on the plant lice and seem to be an important natural check to the increase of the lice.

The turnip root louse, *Pemphigus populi-transversus* Fitch, was found on plants of cabbage, turnips, mustard, and radishes in many places and was causing considerable damage. The lice were found emerging from the ground the last of March, and were determined as of the species which cause the stem galls of cottonwood and poplar trees. A large percentage of the lice in the stem galls were found to be diseased or were attacked by predacious insects or parasitic insects, thus furnishing an important natural control. Sulphur and silicofluorid were used as soil fumigants for the control of the root lice, but the root lice failed to reinfest the treated or check plats and no results were obtained.

Four species of Tenebrionid beetles were found attacking melons on Galveston Island during the month of May. The most abundant species were *Blapstinus pulverulentus* and *B. fortis,* the first named being the most abundant. Under laboratory conditions, poison bait gave a high percentage of kill, ranging from 70 to 98 per cent. Molasses and vanillin formed the most powerful attractive substances tried. It was found that the beetles would live an average of eight days without food. Under field conditions the poison bait gave a high percentage of kill.

Red spiders were dusted with various types of sulphur, but no numerical results were taken, since the infestation ceased to be important after a few days.

Control of Scale Insects on Citrus

The work on this project was carried on at the Lower Rio Grande Station, located at Weslaco, Texas, under the supervision of Mr. Sherman W. Clark, Entomologist.

California Red Scale continues to be the major insect pest of citrus in the Lower Rio Grande Valley and is rapidly becoming more prevalent throughout the whole fruit-growing section. Fumigation experiments were repeated in the winter, using calcium cyanide dust. From the standpoint of scale mortality, fumigation is satisfactory, but reinfestation occurring in the latter part of July and in August caused much damage to the fruit before picking time. Tests of proprietary spray mixtures sold in the Valley in 1928 to determine their relative efficiency in controlling Red Scale show that there is considerable variation in the killing properties of these mixtures. The indications are that oils of low volatility are somewhat superior to the lighter oils in effectiveness in killing Scale. Experiments are under way to determine the effect of oils of low volatility upon the ripening processes in grapefruit.

Oil sprays applied in May and July were more effective in controlling Red Scale than these same materials applied at other times. Tests to determine the feasibility of applying oil sprays late in the season are being tried. Winter spraying is of small benefit in reducing the number of scale insects which will be present during July and August, the period of most rapid increase and spread of the Red Scale. The importance of securing complete coverage of all parts of the tree when spraying with an oil emulsion has been clearly demonstrated by the results this year.

California Red Scale has been found infesting the following plants in the Lower Rio Grande Valley of Texas: Avocado, Salt Cedar (Tamarix gen.), Citrus, Euonymus, Wax-Leaf Ligustrum, and Amoor River Privet.

AGRONOMY

Projects

1. Oat Investigations and Oat Improvement; State funds; P. C. Mangelsdorf, leader.
2. Rotation, Fertilizer, and Soil Improvement; State funds; E. B. Reynolds, leader.
3. Plant Introduction Studies; State funds; E. B. Reynolds, leader.
4. A Fundamental Study of Inheritance in Cotton; Adams and State funds; D. T. Killough, leader.
5. Crop Variety Tests; State funds; E. B. Reynolds, leader.
6. Time and Method of Intertillage; State funds; E. B. Reynolds, leader.
7. Time and Method of Seed-bed Preparation Studies; State funds; E. B. Reynolds, leader.
8. Crop Improvement; State funds; E. B. Reynolds, leader.
9. Rate and Distribution of Seed and Time of Thinning Cotton; State funds; E. B. Reynolds, leader.
10. A Study and Improvement of the Peanut; State funds; G. T. McNess, leader.
11. Composting Raw Rock Phosphate and Sulphur with Different Soils; State funds, and cooperative funds from the Freeport Sulphur Company; E. B. Reynolds, leader.
12. Rice Improvement and Method of Production Tests; State funds, and cooperative funds from The Barrett Company; E. B. Reynolds and R. H. Wyche, leaders.
13. Inheritance in Grain Sorghums; Adams and State funds; A. B. Conner and R. E. Karper, leaders.
14. Wheat Breeding; State and Hatch funds; P. C. Mangelsdorf, leader.
15. Run-off Water Losses in Relation to Crop Production; Purnell funds; A. B. Conner, D. Scoates and R. E. Dickson, leaders.
16. Inheritance of Head Characters in Kafir; Purnell funds; A. B. Conner and R. E. Karper, leaders.
17. Inheritance and Improvement in Corn; Purnell funds; P. C. Mangelsdorf, leader.
18. The Ginning of Cotton in Relation to the Market and Spinning Value of the Lint; State funds and Gin Sales; D. T. Killough and G. T. McNess, leaders.
19. Production of High Nicotine Tobacco; endowment fund from Tobacco By-products and Chemical Corporation, Louisville, Kentucky; G. T. McNess and Earl J. Wilson, leaders.

Oats Investigations and Oat Improvement

Due to the severe freeze late in December, all varieties of winter oats were completely winter-killed at Denton in the season of 1927-1928. This section needs a winter oat that is more cold-resistant than the varieties now available and an attempt is being made to develop such an oat through hybridization of Red Rustproof with such winter types as Hairy Culberson and Winter Turf. The Nortex oat, a pure line selection, developed by Texas Substation No. 6, Denton, and first distributed in 1924, is now grown over a large acreage and has continued to prove superior to ordinary Red Rustproof in yield and uniformity. This variety is not as winter-hardy, however, as ordinary Red Rustproof, due probably to the fact that the commercial run of Red Rustproof contains many off-type plants which are apparently more hardy than the pure Red Rustproof. Nortex oat, however, has proved very productive as a spring-sown oat.

Approximately 1,000 head selections from five commercial strains of Red Rustproof oats were grown at Denton in 1928, in an effort to isolate pure lines of oats which are superior to Nortex in yield, rust resistance and winter-hardiness.

Rotations, Fertilizers, and Soil Improvement Investigations

(a) **Rotation and Fertilizer Work, Main Station:** The work under this phase of the project includes a four-year rotation of cotton, cowpeas, corn, and oats and continuous cotton and continuous corn, to which are applied the following treatments with untreated plats: (1) superphosphate, (2) superphosphate and cottonseed meal, (3) superphosphate and manure, (4) rock phosphate, (5) rock phosphate and manure, (6) manure alone, and (7) crop residue removed. This work has been carried on since 1914.

In 1927, the results were fairly satisfactory. The yields of cotton in rotation ranged from 113 pounds to 217 pounds of lint per acre, while the yields of continuous cotton ranged from 142 pounds to 202 pounds of lint per acre. The highest yield of rotated cotton, 217 pounds of lint per acre, resulted from the treatment of 4 tons of manure and 200 pounds of superphosphate per acre. The largest yield of continuous cotton was produced by the treatment of 4 tons of manure per acre. During the period of the experiment the treatment of manure alone has made the largest yield of cotton.

In 1927, the yield of corn grown in rotation ranged from 23.6 to 35.7 bushels per acre. The yields of corn grown on the same land every year were much lower, and ranged from 13.4 to 23.9 bushels per acre. The highest yield of rotated corn, 35.7 bushels per acre, resulted from the treatment of manure, while for continuous corn the treatment of manure and rock phosphate produced the highest yield, 23.9 bushels per acre.

For the 14 years of the experiment, which includes two crop failures, the treatment of 200 pounds of superphosphate and 100 pounds of

cottonseed meal made the highest average yield of corn, 25.9 and 16.5 bushels per acre for the rotated and continuous corn, respectively.

The fertilizer treatments used have not had any appreciable influence on the yield of oats or cowpeas.

The following definite conclusions may be drawn from the results of the experiment: (1) Rotation has produced significant increases in the yields of cotton and corn. The yield of cotton was increased 14 per cent and the yield of corn 47.5 per cent, in comparison with the yield of continuous cotton and continuous corn, respectively. (2) Manure was the most profitable treatment for cotton, which made an average yearly profit of $6.36 per acre. (3) None of the fertilizer treatments used were very profitable on corn. The application of 107 pounds of rock phosphate per acre was the most profitable treatment, but it made an average profit of only 88 cents per acre. (4) Superphosphate and rock phosphate were equally effective in increasing yields, but the latter was more profitable because it was cheaper. (5) The removal of crop residues (cotton stalks and corn stalks) for a period of 14 years has not produced a significant decline in the productiveness of the soil. (6) The soil, Lufkin fine sandy loam, responded more readily to nitrogenous than to phosphatic fertilizers, indicating a deficiency of nitrogen.

A manuscript reporting the results of this experiment has been prepared for publication as a bulletin of this Station.

(b) **Fertilizer Experiments at Angleton, Beeville, College Station, Denton, Nacogdoches, and Troup:** The objects of these experiments are to determine (a) the best analysis of fertilizer, and (b) the most profitable amount of fertilizer to use on cotton, corn, and wheat on the more important soil types of the State.

Results of these experiments at Angleton on Lake Charles clay and at Beeville on Bee fine sandy clay loam and Goliad fine sandy clay loam show that these soils respond more readily to phosphatic than to nitrogenous or potash fertilizers, indicating a deficiency of phosphoric acid. An application of 200 pounds of superphosphate per acre has been the most profitable fertilizer treatment on cotton used on these soils.

The results of the experiment on Susquehanna fine sandy loam at Troup in 1927 show that applications of phosphoric acid gave larger increases in yield than either nitrogen or potash. Applications of 12-4-0, 12-4-2, and 12-4-4 fertilizers at the rate of 400 pounds per acre were the most profitable treatments used, yielding profits of $14.78, $15.31, and $14.84 per acre, respectively. An application of a 12-4-4 fertilizer at 400 pounds per acre was also the most profitable treatment applied to cotton on Lufkin fine sandy loam at College Station, but it made a profit of only $4.75 per acre.

The results on Nacogdoches fine sandy loam at Nacogdoches show that the soil is more deficient in nitrogen than in phosphoric acid or potash. In 1927, 400 pounds per acre of a 12-6-4 fertilizer on cotton made the greatest profit, $5.38 per acre.

At Denton the fertilizer work is located on San Saba clay. Cotton and wheat are the crops used. The results of the experiment indicate that the soil is more deficient in phosphoric acid than in nitrogen or potash. During the last two years an application of 400 pounds of superphosphate produced an average yield of 371 pounds of lint per acre, or 102 pounds more than the yield of the untreated plats. This treatment was the most profitable one used on cotton. The use of 400 pounds of superphosphate per acre also made the largest yield of wheat, 24.9 bushels per acre, or 6.4 bushels more than the unfertilized plats. The application of 200 pounds of superphosphate per acre, however, was the most profitable treatment for wheat.

(c) **Soil Fertility and Moisture Conservation Studies at Lubbock and Spur:** These studies are being conducted for the purpose of finding a suitable cropping system or systems, including soil-improving crops and practices, best adapted to conditions in northwestern Texas. The work at Lubbock consists of 25 different cropping systems in which cotton and feteria are used. Each of these two crops is grown continuously on the same land with and without manure. They are grown also in all possible combinations with fallow and green manure. The work at Spur is similar, except that fallow is omitted and a leguminous green-manure crop is added to compare with sorgo as a green manure crop.

In 1927, at Lubbock, the highest yield of cotton, 167 pounds of lint per acre, was produced in a two-year rotation of cotton and feterita (the feterita being manured), but the yields ranged down to 101 pounds of lint per acre in a three-year rotation of cotton, feterita (manured), and fallow. A four-year rotation of cotton, green manure, fallow, and feterita produced the largest yield of feterita, 36.3 bushels per acre.

During the 13 years, 1915 to 1927, inclusive, the largest average yields of both cotton and feterita were produced by cropping systems in which manure was used. For example, the three-year rotation of cotton, feterita, and fallow (manured) made the largest yield of cotton, 279 pounds of lint per acre. The manure, however, has produced only small increases in yield of cotton. Cotton grown on the same land every year made an average yield of 254 and 262 pounds per acre where it was unmanured and manured, respectively.

Green manure has not been profitable, since cotton grown on the same land every year made an average yield of 254 pounds of lint per acre for the 13 years as compared with 252 pounds per acre for cotton following green manure.

During the 13 years, 1915 to 1927, the use of the fallow at Lubbock increased the yield of feterita 14.3 per cent, or 3.4 bushels per acre, and the yield of cotton about 3 per cent. These increases in yield are probably not large enough to justify the use of the fallow in the region.

During the last three years at Spur the highest average yield of cotton, 213 pounds of lint per acre, was produced by the two-year rotation of cotton and grain sorghum. Cotton following a legume plowed

under for soil improvement made an average yield of 179 pounds of lint per acre, or 24 pounds more than cotton which followed sorgo plowed under.

The results obtained in these studies for the 13 years, 1915 to 1927, inclusive, show that the use of the fallow and the use of green manure have not been profitable. The results indicate further that the alternate cropping of cotton and grain sorghum is perhaps the most profitable cropping for the region. Such farm manure and crop residues as are available should be used, but the growing of crops only for soil improvement has not been profitable.

(d) **Chemical and Microbiological Studies in Relation to the Productiveness of Soil:** These studies were conducted on soil from the soil fertility plats in the four-year rotation of cotton, cowpeas, corn, and oats, at College Station during three years, 1925, 1926, and 1927, for the purpose of determining the relation between some of the factors of soil productiveness.

These studies included: (a) determination of the quantity of nitrate in the soil under the growing crops; (b) the nitrifying power of the soil; (c) the total nitrogen; (d) the active phosphoric acid; (e) the amount of water in the soil, and (f) the reaction of the soil. The relation of each of these factors to each other and to yield of cotton and corn was studied by the use of statistical methods.

The continuous growing of cotton and corn depressed the amount of nitrates in the soil, but did not appear to influence the nitrifying power of the soil. The soil treated with nitrogenous materials, manure and cottonseed meal, contained larger quantities of nitrates and had a greater nitrifying power than the soil receiving other treatments.

The yield of cotton was significantly correlated with the amount of nitrates in the soil under the growing crop and with the power of the soil to produce nitrates. The yield of corn was significantly correlated with the nitrifying power of the soil, but not with the amount of nitrates in the soil under the growing crop.

Significant positive correlation was found between the amount of active phosphoric acid and the nitrifying power of the soil.

(e) **Rotation of Crops:** At most of the substations, rotation of crops is practiced as a matter of good farming, and to obtain data on the yield of crops and the value of rotation. In general, rotation has increased the yield of crops, but the increases in the Blacklands region have been more pronounced than in other parts of Texas. The results of the studies in rotations in the Blacklands region were published in Bulletin No. 365, "Crop Rotation in the Blackland Region of Central Texas," in September, 1927.

At the Main Station, College Station, a four-year rotation of cotton, cowpeas, corn, and oats increased the yield of cotton 14 per cent and the yield of corn 47.5 per cent as compared with the yields of continuous cotton and continuous corn, over a period of 14 years, 1914 to 1927,

inclusive. A manuscript reporting these results has been prepared for publication.

A four-year rotation of corn, cotton, and peanuts at Angleton increased the yield of cotton five per cent and the yield of corn 85 per cent in comparison with the yield of continuous cotton and continuous corn over a period of seven years.

(f) **The effect of Fertilizers and time of Maturity in Properties of Cotton Fibers:** The object of this study is to determine the effect of different kinds and rates of fertilizers and time of maturity on the properties of cotton fibers, such as length, strength, grade, and spinning value of the fibers. Eighteen different fertilizer treatments are used in the experiment. A large number of blooms, usually 200, are tagged on each plat on the same day at five-day intervals during the blooming period. Tagging at different dates furnishes lint which matures at different times during the growing season. This work has been conducted since 1926 at the Main Station without irrigation and at Iowa Park under irrigation.

To date, approximately 20,000 bolls of cotton have been collected in this study. This material is being analyzed, but the analysis has not proceeded far enough to justify conclusions as to the effect of fertilizers and time of maturity on cotton fibers.

Plant Introduction

This project was carried as usual in 1927, but no outstanding results are reported for the year.

A Fundamental Study of Inheritance in Cotton

The work under this project in 1927 may be grouped under several headings as indicated.

(a) **Hybridization Studies:** In 1926, a cluster-type plant which was probably a mutation, was found in a field of Durango cotton at the Lubbock Station. This plant had numerous short fruiting branches which were axillary in type, few vegetative branches, small bolls lacking storm-resistance, and was very early in maturing. It was thought that this particular type of plant, even though it had some undesirable characteristics, might be of value in developing a strain of cotton that would be better suited to harvesting by machinery than the varieties now generally grown. With this object in mind, this strain was crossed with ten of the more commonly grown varieties of cotton in 1927. The F_1 progeny of the crosses were grown in 1928. A number of promising plants have developed and self-fertilized seed were secured from these for growing the F_2 generation in 1929. The cluster-type of fruiting, characteristic of the Durango parent, is recessive.

(b) **Inheritance of chlorophyll deficiencies:** Two types of chlorophyll deficiencies in the leaves are being studied, one found in the seedling and the other in the adult plant. The results of the studies made on the

seedling type of chlorophyll deficiencies were reported in Bulletin No. 333, "Heritable Chlorophyll Deficiencies in Seedling Cotton."

Studies on the inheritance of cholorophyll deficiencies in the leaves of the adult cotton plant were begun in 1926 and have been continued up to the present time. The virescent yellow leaf character was the first chlorophyll deficiency studied in the adult cotton plant. Two plants having this deficiency were found growing in a field of Mebane cotton at the Spur Station in 1925. The F_1 progeny of each plant was grown in 1926 at the Main Station Farm; the progeny of one plant had only green leaves while the progeny of the other had only virescent yellow leaves. Green-leaved plants of the F_1 segregated in the F_2 in the ratio of approximately three green-leaved plants to one virescent yellow-leaved plant, indicating that a single factor is involved. The virescent yellow plants of the F_1 bred true in the F_2. One class of plants in the F_2 bred true for green leaves in the F_3, while another class segregated in a ratio of approximately three green-leaved plants to one virescent yellow plant. The virescent yellow class in the F_2 bred true in the F_3. In the field the green-leaved plants made on the average 20 per cent more growth, yielded 50 per cent more cotton, and gave better stands of more thrifty plants than did the virescent yellow plants. For these reasons, strains of cotton having the virescent-yellow type of chlorophyll deficiency should be eliminated for breeding purposes.

Another type of chlorophyll deficiency showing angular-shaped areas devoid of chlorophyll in the adult leaves was found in Truitt, Trice, and Acala varieties. Some of the branches on the plant had normal green leaves, while other branches had leaves showing various degrees of chlorophyll deficiency. Plants showing these deficiencies lacked vigor and made lower yields than did the normal green-leaved plants. Self-fertilized seed produced on a branch having this type of chlorophyll deficiency in the leaves produced progeny which also showed the deficiency; while seed produced on a normal green-leaved branch gave progeny which had only normal green leaves. This is apparently a case of cytoplasmic or maternal inheritance.

(c) **Inheritance of Quantitative and Qualitative Characters:** This study was continued in 1928, with the following results: in crosses between long lint and short lint, the former was dominant in the F_1, while segregation in the F_2 generation resulted in some plants having lint which was shorter and longer, respectively, than the lint of either parent. The majority of the plants, however, produced lint of several intermediate lengths.

Crosses between two strains each having 100 per cent of five-lock bolls produced progeny having a small percentage of four-lock bolls, indicating that the parent plants were either heterozygous for this character or that the production of five-lock bolls may be influenced by environmental conditions.

Several factors appear to be involved in the expression of the characters, seed fuzziness and petal spotting in the flowers. Plants in a

hybrid strain in the F_2 generation showed as many as five degrees of intensity of petal spotting in the flower, which may be the result of the action of modifying factors.

In crosses between Egyptian and American Upland strains of cotton the characteristics of the former are dominant in the F_1 generation with respect to type of plant growth, habit of fruiting, color of flowers, shape of leaf, length of lint, seed fuzziness, percentage of lint, and size of boll. Rigid selection in each of the four succeeding generations following this cross has not been successful in obtaining strains uniform for certain of the characters mentioned.

Continued inbreeding of certain strains of cotton for several successive generations has not resulted in any significant decline in the vigor of the plants. The inbred strains were more uniform than strains which were not inbred. Inbreeding in some strains, however, has revealed certain defective characters.

In 1926, a single cotton flower having a stigma with five segments was fertilized with five different kinds of pollen, each kind being placed on a different segment of the stigma. Characteristics of the male parent were readily observed in the F_1 plants of some of the crosses. Red leaf and green leaf characteristics of two of the male parents were dominant in the F_1 to virescent-yellow leaf.

Crop Variety Tests

Variety tests of crops, such as cotton, corn, cowpeas, soybeans, and so forth, are conducted under this project. Tests with cotton, corn, and cowpeas were conducted at the Main Station, College Station, and at the several substations in 1927.

(a) **Variety Tests of Cotton:** Variety tests of cotton were carried at the Main Station, College Station, and at the substations in 1927. As stated in previous reports, Mebane, Lone Star, Truitt, and Acala types of cotton are generally well adapted to the conditions in Texas. Several bulletins have been published recently which report the results of variety tests of cotton at the Main Station and substations, the principal ones being:

Bulletin No. 354, entitled "Varieties of Cotton for the Gulf Coastal Plains, of Texas," reports the results of variety tests of cotton at Substation No. 3, Angleton, for the 13 years, 1914 to 1926, inclusive. Mebane, Kasch, Cliett, New Boykin, Lone Star, Acala, and Truitt are the better varieties for the region. Mebane, T. S. No. 804, was the highest-yielding variety.

Bulletin No. 364, entitled "Varieties of Cotton in Northwest Texas," published in August, 1927, gives the results of variety tests of cotton at Substation No. 8, Lubbock, for the 15-year period, 1912 to 1926, inclusive. A good strain of Mebane is recommended for that part of Texas.

Bulletin No. 366, entitled "Varieties of Cotton in the Red Prairies of

Northwest Texas," published in November, 1927, reports the results of variety tests of cotton at Substation No. 12, Chillicothe, for the eight years, 1919 to 1926, inclusive. Mebane and strains of Mebane (such as Kasch, Cliett, and New Boykin), Lone Star, and Half and Half were the better varieties for that section of the State.

The results of the variety tests of cotton at the Main Station, College Station, are given in Bulletin No. 369, entitled "Varieties of Cotton for East Central Texas." New Boykin, Mebane, Cliett, Kasch, Truitt, Lone Star, Rowden, and Acala were the higher-yielding varieties.

In Bulletin No. 384, entitled "Varieties of Cotton for Central East Texas," are reported the tests of varieties of cotton at Substation No. 11, Nacogdoches, for the 16 years, 1912 to 1927, inclusive. The results show that Half and Half was the highest-yielding variety, but that Lightning Express, Acala, Lone Star, Truitt, and Rowden were the most valuable varieties. Considering yield, length of lint; earliness, and ease of picking, Acala is probably the most suitable variety for the region.

The results of variety tests of cotton at Substation No. 5 (Blackland Experiment Station), Temple, show that Mebane, Kasch, New Boykin, Lone Star, and Rowden are the best varieties for the region. These results are being prepared for publication.

The Division of Agronomy is cooperating with the Department of Agricultural Engineering of the A. & M. College of Texas in studying the adaptability of varieties of cotton to harvesting machinery. Twelve varieties of cotton are used in this work. The type of fruiting, storm resistance, leafiness, propensity for shedding leaves, size of fruiting and vegetative branches, and earliness are studied in relation to mechanical harvesting. The work was begun during this year, 1928, and some material has been collected, but it has not been analyzed and no conclusions are available.

(b) **Variety Tests of Corn:** The previous variety-date test of corn which has been conducted for ten years has been discontinued, and the results are now being analyzed for publication as a Texas Station bulletin. This test has been replaced by a new variety test, including a larger number of varieties, each replicated four times. This test is conducted according to uniform arrangement at ten substations and is so planned that new varieties which are introduced from time to time may be directly compared at each station with the best varieties of that section. This should result in determining in a short period of time not only to which sections a new variety is adapted, but whether or not it is equal to or superior to the standard varieties commonly grown.

(c) **Comparative Regional Adaptability and Productiveness of Corn and Grain Sorghums:** A new project was taken up this year to determine more accurately the comparative regional adaptability and productiveness of corn and grain sorghums, the relative adaptability and yielding ability of the different types and varieties of grain sorghums and under what

conditions grain sorghums may be superior to corn and their planting recommended. This work is principally concerned with the central and eastern parts of the State, and accordingly is being conducted at the substations in these regions where grain sorghum is ordinarily not regularly grown, or grown only in relatively small acreages. Eight selected varieties of grain sorghums are being grown in comparison with the best variety of corn at Beeville, Temple, and Denton substations, while four varieties of grain sorghum are grown in comparison with one variety of corn at the Troup, Angleton, Beaumont, and Weslaco substations, and at the Main Station Farm, College Station. A plat of corn is grown adjacent to each one of the grain sorghums and the plats are replicated four times. This permits analysis of the data by paired comparisons between corn and the grain sorghums and also affords opportunity to determine which of the grain sorghums is particularly adapted to each region. The experiment, which has been conducted this year for the first time, has been successfully handled in each of the regions except the Beaumont Station, where the wet season interfered with obtaining stands. Results of the experiment this year are not yet available for comparison.

Time and Method of Intertillage

The main object of these studies is to determine the effect of different methods of cultivation and the presence and absence of weeds on the yield of crops. Six treatments are included in the work: (1) one cultivation; (2) two cultivations; (3) three cultivations; (4) four cultivations; (5) no cultivation, permitting weeds to grow undisturbed; and (6) the removal of weeds with the hoe, but with no other cultivation. Cotton, corn, and milo are the crops used in the experiment. The work has been conducted at Beeville, Chillicothe, Lubbock, and Spur since 1918. As in previous years, the plats on which the weeds were allowed to grow undisturbed made small yields in comparison with the other treatments. For the ten years of the experiment at Lubbock, the plats on which the weeds were removed with the hoe but which received no cultivation made an average yield of 150 pounds of lint cotton per acre, while the plats which received two to four cultivations produced 192 pounds of lint cotton per acre.

During the seven years of the experiment at Beeville the plats on which the weeds were removed with a hoe, but which received no cultivation, produced an average yield of 122 pounds of lint cotton per acre as compared with a yield of 114 pounds of lint cotton per acre for the plat which received ordinary or frequent cultivation. During the six years of the experiment at Chillicothe, the cotton cultivated in the usual way made an average yield of 300 pounds of lint per acre, while the plats from which the weeds were kept hoed down and were not cultivated produced 255 pounds of lint cotton per acre. These results show that the main value of cultivation is the destruction of weeds. They also indicate that just enough cultivation to control weed growth

is the most effective tillage. These results are in general agreement with the results of similar work in other states.

Time and Method of Seed-Bed Preparation

The objects of this experiment are to obtain information on the effects that different methods, depths, and time of preparing the seed-bed have on the yield of crops. The work includes the following methods of preparation: (1) listing deep (7 inches) and shallow (3½ inches) in the fall, in the winter, and in the spring; (2) plowing deep (7 inches) and shallow (3½ inches) in the fall, in the winter, and in the spring; (3) disking in the fall, in the winter, and in the spring; and (4) listing at planting time. Cotton, wheat, and milo are the crops grown. The experiment has been conducted at Chillicothe and Lubbock since 1918.

Preparing the land by listing or plowing in January made larger yields of cotton than preparation at other dates. At Lubbock, listing 7 inches deep in January produced the largest yield of milo in 1927. For the ten years of the experiment at Lubbock, late plowing, whether deep or shallow, produced the largest yields of cotton and milo. The largest average yield of cotton, 248 pounds of lint per acre, was produced on land plowed 7 inches deep in January. Disking in January gave the lowest yield of cotton, 138 pounds of lint per acre. The results secured to date at Chillicothe do not appear to be conclusive. The results obtained at Lubbock, however, indicate that medium to late plowing at a medium depth is the best method of preparing land in that part of Texas.

Crop Improvement

More work was done in the breeding and selection of cotton than with other crops during the crop season of 1927.

Cotton Breeding: The principal object of this study is to determine the more important characters to be considered in selection which will afford a more adequate and fundamental basis for the breeding and improvement of cotton. This work with cotton, using line-bred material, is being conducted at the Main Station Farm, College Station, and at several of the substations. From 50 to 100 lines of several varieties are being grown, as follows: Mebane, T. S. No. 804, at Beeville and Angleton; Lone Star at Temple; Mebane at Spur; Mebane, Westex and Durango at Lubbock; Mebane, T. S. No. 4120, at Chillicothe; and Startex at the Main Station, College Station. These lines are being inbred to bring about uniformity in the more important characters. After these lines have been inbred for four generations, the more promising ones will be recombined through hybridization.

A statistical analysis has just been completed on 962 plants of Startex cotton at the Main Station. The characters studied include yield, length of lint, percentage of lint, size of boll, and a number of other

characters. The more important significant positive simple correlations found between characters studied were as follows:

Yield of lint and number of bolls	.94±.003
Lint index and seed weight	.78±.01
Yield of lint and number of fruiting branches	.75±.01
Weight of seed and size of boll	.55±.02
Lint index and size of boll	.52±.02
Number of bolls and number of fruiting branches	.50±.02
Yield of lint and size of boll	.46±.02
Weight of seed and length of lint	.37±.02
Lint index and percentage of lint	.35±.02
Yield of lint and weight of seed	.34±.02
Yield of lint and lint index	.32±.02

A multiple correlation of .85 ± .01 was found between the nine independent variables studied and the dependent variable, yield of lint. This value is high enough to indicate that the independent characters studied are closely associated with the yield of lint.

Significant positive partial correlations were found between the following characters studied:

Yield of lint and number of bolls	.98±.001
Yield of lint and number of fruiting branches	.79±.01
Yield of lint and size of boll	.45±.02

Rate and Distribution of Seed and Time of Thinning Cotton

The results obtained in conducting this project were published in 1926, in Bulletin No. 340, entitled "The Effect of Spacing on the Yield of Cotton," and in 1927 in Bulletin No. 360, entitled "The Effect of Spacing and Time of Thinning on the Yield, Growth, and Fruiting Characteristics of the Cotton Plant." The spacing work was discontinued at most of the stations after 1925, but it is still being carried at Chillicothe, Lubbock, and Spur.

In 1927, at Spur, the spacing of 15 inches made the highest yield, 458 pounds of lint cotton per acre. During the last six years, however, the 12-inch, 15-inch, and 18-inch spacings made almost identical yields, 282, 285, and 282 pounds of lint cotton per acre, respectively, which yields were larger than those of other spacings.

At Chillicothe in 1927, the 12-inch spacing produced the largest yield, 482 pounds of lint per acre, while the 18-inch spacing ranked second with a yield of 475 pounds. For the eight years, 1919 to 1927, omitting 1923, the 18-inch spacing made the highest yield, 355 pounds of lint cotton per acre, or only seven pounds per acre more than the yield of the 24-inch spacing, which ranked second.

The work at Lubbock, in 1927, included different varieties, planted at different dates, the plants being thinned to 6, 12, and 18 inches apart in 36-inch rows. The experiment, however, was somewhat unsatisfactory on account of lack of moisture. The plantings in April and May were failures, while poor stands resulted from the planting in

June. The results from 1913 to date indicate that spacing of 12 to 15 inches is the optimum spacing at Lubbock.

A Study and Improvement of the Peanut

During the past year the work under this project consisted of (a) variety tests of peanuts at the Main Station, College Station, and at the substations at Angleton and Nacogdoches, and (b) selection and improvement of the Macspan peanut at College Station and Nacogdoches. The Macspan peanut is being increased at both College Station and Nacogdoches for distribution to farmers.

The results of this project have been published in Bulletin No. 381, entitled "Peanuts in Texas."

Composting Raw Phosphate Rock and Sulphur with Different Soils

The main object of these studies during the last few years has been to determine the value of sulphur as a fertilizer for different crops on several of the important soil types in the State. Sulphur has been applied in amounts from 50 to 10,000 pounds per acre. The work has been conducted at Angleton, Beeville, College Station, Nacogdoches, Temple, and Troup.

On the black limestone soil at Temple, sulphur has been applied at rates ranging from 50 to 4,000 pounds per acre to cotton, corn, and oats, and as high as 10,000 pounds per acre to cotton. The results of this experiment show that applications of sulphur in amounts up to 2,000 pounds per acre has no significant influence on the yield of crops, but larger amounts caused a slight reduction in yield.

Sulphur applied at the rate of 250 and 500 pounds per acre to cotton, corn ,and cowpeas on Lake Charles clay at Angleton had a tendency to reduce the yields of these crops slightly, as an average of the results for 1925, 1926, and 1927.

The use of 100 to 200 pounds of sulphur per acre on cotton and cowpeas on Bee fine sandy clay loam and on Goliad fine sandy clay loam at Beeville had no significant influence on the yield of these crops in 1926 and 1927. Similar results were obtained on Lufkin fine sandy loam soil at the Main Station, College Station, during these two years.

Applications of 250 and 500 pounds of sulphur per acre to cowpeas on Susquehanna fine sandy loam soil at Troup in 1925, 1926, and 1927, did not have any appreciable effect on yield. Similar results were secured at Nacogdoches.

The results with sulphur secured at these six points in Texas indicate that sulphur is not needed as a fertilizer on the soils in the Blackland region of Texas, on the Lufkin soils just east of the Blackland belt, on the sandy soils in eastern Texas, and on the black soils of the Gulf Coastal Plains of Texas.

Rice Improvement and Methods of Production Tests

The work conducted under this project has consisted mostly of tests of varieties of rice, inheritance of characters in rice, and experiments with fertilizers and lime.

(a) **Variety Tests of Rice:** The test included 32 varieties in 1927. The three highest-yielding varieties in the order named were: Blue Rose, T. S. No. 8973, with a yield of 2,380 pounds of rough rice per acre; Early Prolific, T. S. No. 8972, with a yield of 2,304 pounds; and T. S. No. 5321, with a yield of 2,214 pounds per acre.

The results of the variety test during the last four years indicated that Blue Rose and Early Prolific varieties, which have medium-length grains, and Texas Fortuna, with a long grain, are the best varieties for the region.

(b) **Inheritance of Characters in Rice:** The material collected in 1927 has not been analyzed, and consequently no results are reported.

(c) **Fertilizers and Lime:** The main object of the work with fertilizers on rice is to find the fertilizer requirements of rice, including the best kind, amount, and time of application of fertilizers on the rice soils of the region. The application of 100 pounds of sulphate of ammonia per acre gave the largest increase in yield in 1927. This treatment also made the largest yield during the 12-year period, 1915 to 1927, inclusive, and was the most profitable treatment used.

The application of 2,000 pounds of lime per acre to rice did not affect the yields of rice, although apparently it reduced the weight per bushel, during the season of 1927.

Inheritance in Grain Sorghum

Measurements have been taken during the year on a population from each of 18 varieties or strains of grain sorghum, including the groups of Yelow milo, White milo, Blackhul kafir, feterita, and kaoliang. These 18 varieties make up what appears to be a parallel series of height variations in the above five groups of sorghums, each group having a height series which is classed as standard, dwarf, and extra dwarf in stature. Statistical constants on eight characters, including height of plant, have been calculated from a population of 50 individual plants from each of the 18 strains of these different varieties and groups of grain sorghum grown in the season of 1927. A number of hybrids between these height series have been made and records of the performance of the F_1 hybrids in comparison with the parents have been taken this year, with the view of determining the mode of inheritance of height and also using the measurements and records for arriving at the degree of hybrid vigor displayed and the resultant increase in forage and grain yields in the F_1 and F_2 generations.

Analyses of the protein content of the grain of the strains making up the series in these groups of grain sorghum seem to show that there

is little relation between the height of the strain and the protein content of the grain, but that there is a significant difference in the protein content of the grain of the different groups. The average protein content of the feterita group is 12.93 per cent; kafir, 11.19 per cent; milo, 10.52 per cent; and the kaoliang group, 10.53 per cent. While feterita, as a group, runs higher in protein than the other sorghums, the Dwarf feterita variety has consistently shown a higher per cent of protein than the other strains of feterita.

The kafir inbreeding and head type study has been continued this year, as in the past, and complete records on all of the characters studied have been recorded for future analysis. The calculation and tabulation of the correlation between each of the ten pairs of head and plant characters in Blackhul kafir, including a crib-run population of 652 plants, progeny of 1,066 plants from 80 selected heads and five pure lines of 100 to 150 plants each, have been completed and prepared for publication. The simple, multiple, and partial correlation coefficients indicate that the characters, length of head, length of seed branches, diameter of plants, and weight of green forage are the ones that, either in themselves or through them by other characters, contribute significantly toward production of yield of grain. The multiple R is practically as high when only these four characters are included as when the other five characters were also taken into consideration.

A chlorophyll deficiency in Blackhul kafir, classified as pale yellow or virescent yellow, which gave a segregation in the ratio of 7.3:1 when crossed with normal green plants last year, has been further propagated during the present season by growing additional F_1 plants for further testing and growing the F_2 generation to maturity in order to determine the performance of these progeny in the F_3. Each of the individual F_2 progeny plants was bagged to prevent cross-fertilization and will be grown in flats in the greenhouse during the coming winter to determine its behavior.

In the inbreeding work with grain sorghums, chlorophyll-deficient strains have been found in three of the eight pure lines of kafir being studied. Plants segregating for albinos and pure greens in a 3 : 1 ratio have been found in Line 223. Where these chlorophyll deficiencies have a completely lethal effect in the homozygous state, the result is that a certain percentage of the plants die in the seedling stage, the stand is impaired, and a resultant loss in yield follows. Two-thirds of the remaining plants are heterozygous carriers of this lethal factor and a study is being made this year on the effect of albinism upon plant development and yield when this lethal factor is present in a heterozygous condition or in the two-thirds of the green plants which survive and reach maturity in the field. Since the strain of kafir in which this chlorophyll deficiency occurred was inbred for six generations and was a pure line when the mutation of this factor occurred, the only difference between the homozygous plants and the heterozygous plants carrying albinism should be in this single factor, and this is excellent material

for the study of the effect of a single gene upon development. Approximately 600 plants are being grown upon which height measurements at 10-day intervals are taken, and notes on other characters will be recorded at maturity. Identification of the homozygous and heterozygous plants will then be determined and the data analyzed for the difference in development of the plants carrying the factor for albinism and those lacking this factor.

The inheritance of another chlorophyll deficiency in Blackhul kafir, which produces pure green, striped yellow and green, and pure yellow seedlings, is being studied. This appears to be a chimera and is probably a case of maternal inheritance in sorghum, since the three classes of progeny do not occur in numbers corresponding with any definite ratio but seem to be confined to different areas on the panicle. Crosses and reciprocal crosses are being made with other normal green sorghum plants in order to determine definitely whether or not this is a Mendelian character and transmitted both by the ovules and pollen grains.

Material for determining the chromosome number of sorghums has been collected for a number of the important groups of sorghum, and it is hoped to make counts on the chromosome number of these sorghums. A high degree of sterility has been found in some of the progeny of crosses between kafir and milo. Parental and progeny material grown and collected this season will be studied for chromosome number in order to determine whether any irregularity in this respect accounts for the partial sterility in this cross.

Wheat Breeding

Denton wheat, a pure line selection of Mediterranean, which was first distributed in 1926, has now been grown in a number of counties in North Texas and has proved to be well adapted throughout the section which now grows Mediterranean wheat. Denton wheat has exceeded in yield the following varieties in a six-year test at Texas Substation No. 6, Denton: Kanred, Clark's Blackhul, Mediterranean, and Fulcaster.

Two years' results from tests on the breaking strength of straw show Denton wheat to have a straw that is stronger by 26.3, 39.7, 53.2, and 78.8 per cent than Mediterranean, Fulcaster, Clark's Blackhul, and Kanred, respectively.

Two years' results from milling and baking tests indicate that bread baked from Denton wheat is superior in loaf volume, texture, and color to that baked from Mediterranean, Kanred, Blackhul, Fulcaster, and Alabama Bluestem grown in North Texas.

All available data on yield, rust resistance, strength of straw, and baking quality of Denton wheat have been assembled for publication.

Present wheat-breeding operations are being concentrated on improvement through hybridization. First generation hybrids of Kanred X Denton, Kanred X 3015-63, Denton X 3015-63, and 3015-63 X Foisy were grown in the greenhouse the past season and a large supply

of seed for planting the second generation has been obtained. Additional hybrids involving other varieties have also been made. The object of this work is to combine into one variety, so far as possible, the characteristics of high yield, resistance to leaf and stem rust, stiffness of straw, and good milling quality. All of the varieties used in hybridization are outstanding for at least one of the characters.

Inheritance of Head Characters in Kafir

The object of this project is the study of inheritance of four head characters in crosses between two line-bred strains, Nos. 223 and 654. Characters studied are number of seed branches, number of nodes to the head, length of rachis, and length of seed branches, the parents having shown widely different means for these characters. These are largely quantitative characters, which are being studied statistically. Data on the measurement of these characters recorded from the parents for a number of years, together with that of the F_1 and F_2 generation material, are being compared, and the F_3 generation was grown for a verification of the inheritance of these characters as shown by the F_2 material. Analysis of these data is being continued with the view of establishing the manner of inheritance of these head characters in grain sorghum.

Inheritance and Improvement in Corn

This project is rather sharply defined into two main phases: (1) Breeding operations designated to improve the yield of Texas varieties of corn. (2) Fundamental studies of heredity of the corn plant to serve as a foundation for progress in breeding methods.

The breeding work is largely confined to selection in self-fertilized lines. The corn plant, which is naturally cross-pollinated to a high degree, can be artificially self-pollinated by bagging silks and tassels and pollinating the ears with pollen from the same plants. This procedure, which is a very intensive form of inbreeding, concentrates the heredity, permits the elimination of inherited abnormalities, and results in the isolation of uniform, true-breeding strains.

This work is now in its second season in Texas. Approximately 6,000 ears, representing 1,600 strains, from the varieties Surcropper, Tuxpan, Thomas, Yellow Dent, Nacogdoches, Blue Grain, Mexican June, and Mosshart, were self-pollinated at College Station and at five substations in 1928.

The most striking results of the past season were the large number of inherited abnormalities which appeared. In the Surcropper variety, one plant in seven proved to be segregating for defective seeds, and one plant in ten segregated for albinism or other chlorophyll deficiencies. In addition to these characters, which are lethal in effect, many strains showed segregation for golden color, striping, various types of dwarfness, sterility, abnormal seed-producing habits, and others. The most peculiar abnormality observed occurred in a strain of Tuxpan, in which

some of the plants exhibited a distinct "creeping" habit. The proportion of strains which segregated for abnormalities of various kinds has been much higher in Texas varieties than is ordinarily encountered.

Studies of inheritance in corn have been somewhat delayed by the necessity of crossing certain genetic stocks with inbred strains of Texas corn in order to secure stock better adapted to Texas conditions. The following problems are being considered:

1. A stock in which sugary endosperm segregated in proportions ranging from 5 per cent sugary to 75 per cent sugary is being studied cytologically to determine whether the abnormal segregation is associated with irregular chromosome behavior. Considerable variations has been found in chromosome number, but it has not been possible as yet to interpret the peculiar genetic behavior on this basis.
2. Additional studies of the segregation of sugary seeds in hybrids of Rice Pox X sugary indicate that the percentage of sugary seeds first increases and later decreases as the stylar distance is increased. This suggests that rate of pollen tube growth is first higher for the *Su* pollen grains but is later exceeded by the *su* grains.
3. A study of the relation between number of seminal roots and yield, seedling vigor, plant height, and other characters was made in Surcropper corn. It was found that the number of seminal roots varies with the position on the ear, with temperature, moisture, and degree of heterozygosity of the stock, but that ears having varying averages numbers of seminal roots maintain the same relative ranking, no matter under what conditions the number of roots is determined. In other words, every ear has a characteristic average number of seminal roots, which varies greatly within the same variety. Contrary to the results of other workers, there proved to be practically no relation between number of seminal roots and yield.

Cotton Ginning Studies

Cotton-ginning studies were begun in 1926, to study a number of factors concerned in ginning cotton as they may relate to the market value of the lint, particularly speed of the saws, the tightness of the roll and cleaning apparatus on the grade, length, and spinning value of the lint. Samples have been obtained from the experimental gin where the same variety has been ginned under similar conditions with the exception of the particular factor being considered.

Replications have been frequent. The measure of the grade and length of staple have been obtained by submitting the samples to licensed cotton graders for determinations. The spinning values have been measured by spinning tests. The results indicate that certain conditions of ginning affect the length of the lint and the grade of the cotton, but since this work is in the preliminary stage it is difficult to say whether or not these conditions apply to ginning as it is practiced.

Production of High Nicotine Tobacco

The object of this work is to compare and determine the relative value of *N. tobaccum* and *N. rustica* with regard to nicotine content, yield from different methods of planting, and for seed production. The field work was done in 1927 at Substation No. 16, Iowa Park,

in cooperation with the Tobacco By-Products and Chemical Corporation, Louisville, Kentucky. The results show that the tobacco grown was not suitable for the purpose desired.

Run-Off Water Losses in Relation to Crop Production

Soil and Water Conservation Studies

The object of this work, started in 1926, is to determine the water and soil losses which occur in the region and the principal factors which affect losses of both soil and water, with a view of perfecting methods and practices which will minimize these losses.

The total rainfall during the crop-growing season of the year was 16.79 inches, of which 4.39 inches came as ineffective showers. Of the remaining rainfall which occurred, 3.70 inches was lost on land with a two per cent slope, leaving a total of 8.70 inches, or approximately one-half of the total rainfall, for the effective use of the crop. With every inch of water lost, there was lost approximately three tons per acre of soil by erosion, and these results seem to be in conformity with the results secured during the two previous seasons.

The crop grown on the land seems to be a factor of considerable importance in the loss of both water and soil, grass being found more effective in conserving both soil and water than any other crop and milo more effective than cotton.

The slope of the land exerts, of course, a considerable influence, but the results thus far indicate that the loss of water and soil is not in direct proportion to the slope of the land, and it is desirable to have more definite information as to the relation of the slope of the land to these losses. The work thus far indicates that the percentage of water in the soil is a factor of considerable importance in relation to losses but thus far no satisfactory and quick-recording measure of the percentage of water in the soil has been devised.

Two field plats with a fall of two feet between terraces but one with the terrace built on contour lines and the other with the terrace built with a fall of three inches to the hundred feet showed a difference of 20 per cent in the amount of water lost in favor of the level terrace, and these results are, in general, in accordance with the results secured during the two previous seasons on the same plats.

A preliminary report giving the results secured thus far is in preparation for publication.

PLANT PATHOLOGY AND PHYSIOLOGY

Projects

1. Cotton Root Rot Investigation; Adams and State funds; J. J. Taubenhaus, leader.
2. Tomato Diseases; Hatch and State funds; J. J. Taubenhaus, leader.
3. Diseases of Cabbage, Lettuce, and Spinach in Texas and Their Control; Hatch and State funds; J. J. Taubenhaus, leader.

4. A Study of Pecan Scab and Related Diseases of the Pecan; Hatch, State, and cooperative (with School of Agriculture) funds; J. J. Taubenhaus and G. W. Adriance, leaders.
5. A Study of Diseases of Perishable Crops in Transit and Methods of Control; cooperative funds from Western Weighing and Inspection Bureau; J. J. Taubenhaus, leader.
6. Preliminary Studies with Sulphur or Strong Bordeaux Causing What is Termed "Burning" of Foliage in Cucurbits; State and cooperative (with Freeport Sulphur Company) funds; J. J. Taubenhaus and W. H. Friend, leaders.

Cotton Root Rot Disease

The problem of the cotton root rot disease is a serious one, particularly in the Houston black clay soil and soils of a similar nature.

The control of cotton root rot under field conditions is dependent very largely upon a complete knowledge of the life history of the fungus and its environment. Accordingly, life history studies are of primary importance. Realizing the seriousness of the problem, the research program has involved, however, not only life history studies, but also the testing out of various possible means of control, using our present limited knowledge of the life history of the fungus and observations in the field to suggest methods which offered hope of effective control of the disease.

Life history studies have included studies of the fungus itself as a means of spread of the disease and also of the spore stage or seed stage and its relation to the carry-over of the disease in the field. It has been found that infected live roots play an important role in the spread of cotton root rot. Even after cotton is plowed up, the lateral roots left in the soil remain alive and in good condition and serve as hosts for carrying over the fungus to the succeeding crop. It has been found that where the soil was sifted to remove roots cotton root rot did not appear in the sifted plats the succeeding year; whereas on the unsifted plats, the disease was prevalent. Whether these results would apply under undisturbed conditions of the soil in the field remains to be seen, but it seems certain that infected live roots are a factor of importance in the carry-over of the cotton root rot fungus.

Numerous attempts have been made to isolate the causal organism from the soil or from dead roots previously infected by the disease, but without success. Spores have been collected and attempts made to germinate them under artificial conditions, and while germination has started, no successful growth from spores has been attained, due, possibly, to a lack of knowledge as to favorable environmental conditions.

Observations in the field seem to indicate that the root rot fungus is inhibited by certain physical or chemical conditions in the soil. Thus the disease is not prevalent in numerous and widely scattered bottom soils throughout the Blackland region; whereas it is very common on adjacent sloping hillsides. This absence of root rot in bottom lands is apparently not due to a lack of proper environment for the fungus during the growing season, since plants in one such area have been in-

fected by artificial inoculations. The disease survived the winter and established itself the second year with several new centers. This suggests that if the disease is normally absent from these areas, due to some physical or chemical condition in the soil, these conditions must exist at irregular intervals and perhaps only for short periods of time. This infection will be observed from year to year to determine whether or not it persists or is eliminated in the course of time by some changing conditions.

It has been shown that the prevalence of root rot is influenced by the hydrogen ion concentration of the soil. In experiments this year, seven different soil types have been used by taking the soil material and placing the surface and subsoil in the order in which they appeared under natural conditions. Cotton plants grown in those soils which were neutral or alkaline succumbed to root rot; whereas plants in the Susquehanna and the Tabor soil materials remained free from the disease notwithstanding repeated artificial inoculation.

Experiments have been conducted with common salt as a means of control, making applications at the rate of 200, 500, 1,000, and 3,000 pounds to the acre; but these applications have shown no effective control in any case. Oxidized sulphur has been applied experimentally as a control measure; results of this work are as yet incomplete. The effect of different fertilizers has been tested but thus far no results have been obtained to show that fertilizers and other chemicals are effective in inhibiting the disease. Preliminary work is in progress on the effectiveness of chemical disinfectants as a means of control.

Numerous varieties and strains of cotton are being tested for resistance or immunity to cotton root rot. No variety or strain has yet been found which is immune to the disease. The method consisted in artificially inoculating the plants under test, using the percentage of uninfected plants as a measure of resistance. No variety or strain is eliminated until it has been shown to be entirely susceptible. There are so many factors involved in obtaining a measure of resistance that this work must be done carefully and repeated with such varieties and strains as show any possible resistance to the fungus. It is obvious that the securing of an immune strain, or even a strain which possesses a considerable degree of resistance, might avoid or delay the effects of the disease and result in greatly minimizing the loss.

Tomato Diseases

No research work has been done during the year on this project.

Diseases of Cabbage, Lettuce, and Spinach

No research work has been done during the year on this project.

Pecan Scab and Related Diseases

No research work has been done during the year on this project.

Diseases of Perishable Crops in Transit

The work under this project has been continued during the year in gathering data on the cause of various diseases in fresh fruits and vegetables as they occur in transit.

Sulphur as a Fungicide

Sulphur is known to cause serious "burning" of cantaloupe leaves and of the foliage in cucurbits in general. Various ingredients combined with sulphur have failed to minimize the damage from "burning." Experiments thus far have not resulted in effectively controlling with sulphur *Sclerotium rolfsii,* or damping off disease. Cotton has shown itself to be very tolerant of high acidity induced by the oxidation of sulphur in the soil.

Plant Disease Survey

The Plant Disease Survey has been continued during the year. This work consists of gathering data on the prevalence and the distribution of plant diseases and plant disease epidemics in the State and is conducted in cooperation with the Bureau of Plant Industry, United States Department of Agriculture. Data relating to this work have been compiled for the past eleven years and during the forthcoming year it is proposed to digest this material with the view of arriving at a better understanding of plant diseases prevalent in the State.

FARM AND RANCH ECONOMICS

Projects

1. Study of Ranch Organization, Methods and Practices and Costs of Range Livestock Production in the Edwards Plateau Region of Texas; in cooperation with the Bureaus of Agricultural Economics and Animal Industry, U. S. Department of Agriculture; State, Purnell, and cooperative funds; L. P. Gabbard, G. S. Klemmendson and V. V. Parr, leaders.
2. Study of the Carrying Capacity of the Pastures of the Ranch Experiment Station in Sutton-Edwards Counties; State and local funds; L. P. Gabbard, V. L. Cory and W. H. Dameron, leaders.
3. Range Vegetation of the Edwards Plateau; State funds; V. L. Cory, leader.
4. Activities of Livestock on the Range; State funds; V. L. Cory, leader.
5. A Study of Farm Organization, Methods and Practices, and Costs of Production of Farm Products in a Typical Blackland Cotton Farming Area of Texas; in cooperation with the Bureau of Agricultural Economics; Purnell, State and cooperative funds; L. P. Gabbard and J. B. Hutson, leaders.
6. A Study of the Type-of-Farming Areas in Texas; in cooperation with the Bureau of Agricultural Economics; Purnell, State and cooperative funds; C. A. Bonnen and F. F. Elliott, leaders.
7. A Study of the Organization and Operation of Farms in East Texas; in cooperation with the Bureau of Agricultural Economics; Purnell, State and cooperative funds; C. A. Bonnen and J. B. Hutson, leaders.
8. Economic Significance of the Different Methods of Harvesting Cotton; Purnell and State funds; L. P. Gabbard and D. L. Jones, leaders.

9. Local Cotton Marketing Study; Purnell and State funds; L. P. Gabbard and G. L. Crawford, leaders.
10. Factors Influencing the Marketing of Winter Vegetables in the Lower Rio Grande Valley; Purnell and State funds; G. L. Crawford, leader.
11. Economic Factors Influencing the Marketing of Winter Vegetables in the Lower Rio Grande Valley of Texas; Purnell and State funds; G. L. Crawford, leader.

Ranch Organization and Practices

This is a cooperative project in which the Bureau of Agricultural Economics and the Bureau of Animal Industry of the United States Department of Agriculture are cooperating with the Texas Agricultural Experiment Station in the collection of records from a group of ranches for tabulation and study as to the relative importance of different methods and practices and their coordination in influencing the income from the ranch. Detailed records from 29 ranches have been secured in 1927, which provide a complete three-year record on 23 ranches. These data are being assembled, tabulated, and studied with a view of determining some of the important principal factors and their relation to income.

At the close of the year, statements have been returned to each cooperator showing the distribution of investment, the operator's earnings, cost of production for mohair, wool, and calves, and a factor sheet which enables the ranchman to compare important items in his ranching operations with the average of his neighbors who are cooperating in this study.

Carrying Capacity of the Pastures of the Ranch Experiment Station

The object of this project is to check the application of a proposed carrying capacity of 70 units per section in the proportion of 31 units of cattle, 26 units of sheep, and 13 units of goats. After securing actual weights on the mother cows on the Station ranch, a 900-pound cow has been used as the unit instead of a 700-pound cow. This unit reduces the units per section to 52 in the proportion of 23 units of cattle, 19 units of sheep, and 10 units of goats.

CARRYING CAPACITY UNITS BY TYPES OF LIVESTOCK FOR THE SIX MAIN PASTURES OF THE STATION RANCH, 1924, 1925, 1926, and 1927

	*Standards	1924	1925	1926	1927
Cattle	23	34.62	26.44	28.03	27.70
Sheep	19	25.85	21.41	24.47	24.41
Goats	10	13.92	10.85	13.19	12.23
Total	52	74.39	58.70	65.69	64.34

*The standard originally used was 70 units per section—31 cattle, 26 sheep, and 13 goats. The unit of measure used was 5,591 pounds of dry matter, the amount necessary to maintain a mother cow weighing 675 pounds at the beginning of the year, 750 pounds at the end of the year, averaging 712½ pounds, thus providing for 75 pounds of gain (Texas Station Bulletin No. 297). Four weighings per year show an average weight of slightly above 900 pounds for mother cows on the Station Ranch. For this reason a 900-pound mother cow has been used as the unit and the standard becomes 52 instead of 70 units per sec tion—23 cattle, 19 sheep, and 10 goats.

The table given above shows the number of carrying-capacity units consumed by the different classes of livestock for the years 1924, 1925, 1926, and 1927, compared with the standard being checked. It will readily be seen that all of the years are above the proposed standard and especially the year of 1924. Grazing conditions for the year 1924 were exceptionally good and the Station ranch was heavily stocked. The range was very poor during the winter and spring of 1925. Such conditions make it necessary to do a great deal of supplemental feeding and are generally followed by heavy death losses and relatively low calf, lamb, and kid crops.

Range Vegetation of the Edwards Plateau

This project has for its object a study of the character and economic importance of native vegetation of the Edwards Plateau region for grazing purposes. During the year typical areas of about eleven acres in each of the six main pastures of the Ranch Experiment Station have been selected for mapping and detail study. Each of the designated areas is to be studied over a period of at least two years with the view of obtaining the following information:

1. To identify, classify, and catalogue the different species, and to estimate the pasturage of the particular species to the total forage.
2. To determine the production periods of the different species. The task here is to indicate when the different forage plants are available and significant for purposes of grazing range livestock.
3. To determine the different types of vegetation and the relative extent of each. These types are designated as open grass lands, oaks, brush, saccahuista, and so forth.
4. To collect samples of the important types of vegetation for chemical analysis.

The data on this project have not been tabulated and summarized. A considerable amount of identification work for the Station ranch and the Plateau in general has been done. Maps have been made of definite areas in Pasture G and are being made for the five other main pastures of the Ranch Experiment Station. These maps will serve as a basis for indicating a detailed study and identification of range plants.

Activities of Live Stock on the Range

This project was completed during the year and the results were published in Texas Station Bulletin No. 367, entitled "Activities of Livestock on the Range."

A Study of Farm Organization, Methods and Practices, and Cost of Production of Farm Products in a Typical Blackland Cotton Farming Area in Texas

This is a cooperative project between the Texas Agricultural Experiment Station and the Bureau of Agricultural Economics, United States Department of Agriculture. The object of this project is to study and

suggest systems of farming that appear likely to give the best returns over a period of years. As a basis for developing such systems it is necessary to determine:

1. Normal crop yields and requirements.
2. Normal livestock and production requirements.
3. Normal building, machinery, fence, and automobile expenses.
4. Expected prices of products sold and of items bought. Such data have been secured through detailed records kept by a selected group of farmers in the area, supplemented by Experiment Station records, survey records, and reliable information from other local sources.

The field work on this project was closed out January 1, 1927, and a study of similar character was begun in East Texas. A manuscript entitled "Systems of Farming for the Black Waxy Prairie Belt of Texas," is nearing completion. It is hoped to develop another publication from the detail data collected in this project, on the cost of producing cotton and other crops, such as corn and oats.

A Study of the Type-of-Farming Areas in Texas

This study is conducted in cooperation with the Bureau of Agricultural Economics, United States Department of Agriculture, and was begun April 1, 1928. The objectives are as follows:

1. To outline and describe the different type-of-farming areas in Texas in which there are similar crop and livestock organizations and similar physical conditions with respect to soil type, climate, and topography.
2. To determine present organizations of farms in these areas, changes which are taking place in the type of farming in each area, and the factors responsible for these changes.
3. To set up typical farming systems for farms of different sizes for use as a basis for suggesting both long-time and year-to-year adjustments in farming systems in the light of changing economic conditions.
4. To provide descriptive and historical material to serve as a background or guide for more detailed studies to be made in the different type-of-farming areas.

Much of the data have already been tabulated for this study and it is expected that the results will be available in bulletin form by the latter part of 1929.

A Study of the Organization and Operation of Farms in East Texas

This study was started in January, 1928, and is cooperative with the Bureau of Agricultural Economics, United States Department of Agriculture. The principal object of the project is to determine the systems of farming likely to give good results in the area over a period of years, including enterprise combinations which appear advantageous, practices giving good results in the principal enterprises, and adjustments between and within the enterprises likely to be desirable under changing economic conditions.

The work on this project to date has been confined almost entirely to the collection and tabulation of data. Detailed records of the work

done, of material used, of resources available, and of all financial transactions are being secured on from twenty to twenty-five farms in the area. These data, along with other experimental data and such information as will be provided in the type-of-farming study, will serve as a basis for conclusions as to the best systems of farming for the area.

Economic Significance of the Different Methods of Harvesting Cotton

The object of this project is to determine the economic significance of the different methods of harvesting and ginning cotton in the high plains region of Northwest Texas. Special emphasis is being placed on the new method of harvesting known as "sledding," with the view of pointing out its probable effect on the economics of cotton production in the area. In detail, the object of the project is to compare picked, snapped, and sledded cotton when ginned with different amounts of cleaning, as to yields, cost of harvesting, cost of ginning, grade, staple, market value, and spinning utility. During the season of 1927, nineteen lots of cotton were harvested by the following methods and ginned under the following conditions:

Picked:

1. Run through gin stand saws only.
2. Run through Mitchell burr extractor only and gin.
3. Run through all Stacy cleaners, and Mitchell burr extractor.

Snapped:

1. Run through Mitchell burr extractor only before ginning.
2. Run through all cleaners, Stacy and Mitchell and gin.
3. Run through Mitchell burr extractor on Station (farm unit of saw cleaner) and run through all cleaners, Stacy and Mitchell and gin.
4. Snap (pull) only open bolls, and run through all cleaners, Stacy and Mitchell, before ginning.

Sledded:

1. Run through Mitchell burr extractor only before ginning.
2. Run through all cleaners, Stacy and Mitchell and gin.
3. Run through Mitchell burr extractor (farm unit of saw cleaner) and run through Stacy cleaners and Mitchell burr extractor and gin.

This project is being conducted through the season of 1928, and will probably continue over a period of three to five years.

Local Cotton Marketing Study

The object of this study is to determine the degree to which local markets distinguish between the different grades and staples of cotton and to what extent the prices paid in the central markets are reflected in the prices paid upon the local markets.

A tentative report of the data collected during the season of 1925 was published in July, 1928, as Texas Station Bulletin No. 383, entitled "Relation of Farm Prices to Quality of Cotton." The significant facts in the report are: (a) a tendency of the local trade to recognize

middling and the grades near it, and to penalize rather severely both high and low grades; (b) there was very little, if any, evidence of a conscious effort on the part of local buyers to recognize staple differences in the price paid producers on the individual bale basis, and (c) it was quite evident that prices tend to conform to the average quality of the cotton produced in the community.

This study will be continued through 1928-29. At the close of the period the data for the three seasons will be presented in a final publication.

Factors Influencing the Marketing of Winter Vegetables in the Lower Rio Grande Valley of Texas

This project was completed during the year and the results were published in Texas Station Bulletin No. 378, entitled "Services, Facilities, and Costs of Marketing Vegetables in the Lower Rio Grande Valley of Texas."

Economic Factors Influencing the Marketing of Winter Vegetables in the Lower Rio Grande Valley of Texas

The object of this study is to determine the most important outside influences in the marketing of vegetables in the Lower Rio Grande Valley of Texas. It is a companion study of Project No. 205, "Factors Influencing the Marketing of Winter Vegetables in the Lower Rio Grande Valley of Texas," which deals more specifically with the local influences affecting the marketing of winter vegetables. Central markets, such as Dallas, Fort Worth, and St. Louis were visited during the year and information secured on such factors as transportation facilities, selling agencies employed, and methods used. The data collected are being tabulated and summarized for publication.

SOIL SURVEY

During the last fiscal year, soil survey work was carried on continuously throughout the year in cooperation with the Bureau of Chemistry and Soils of the United States Department of Agriculture. The projects covered included detailed surveys in five counties and a reconnaissance survey of the region west of the Pecos River. About 1,500 square miles were completed in detailed surveys, while the area in reconnaissance survey comprised the completion of an area of about 31,000 square miles, this project having been started in the summer of 1927.

Van Zandt and Midland Counties, projects carried over from the previous year, were completed and the maps and reports were presented for publication. Field work was started in surveys of Frio, Potter, and Polk Counties and continued for several months prior to the close of the fiscal year. Van Zandt County lies within the western edge of the East Texas Timber region where sandy soils with clay subsoils

predominate. The soils in this county are found to be well suited to many truck crops, fruits and berries, while cotton, corn, and small grains can be grown profitably on certain soil types.

Midland, on the south plains of the Llano Estacado, has considerable areas of soils well suited to cotton and grain sorghums, as well as other crops, and considerable farming is being successfully carried on. Certain soils of this county, however, appear to be better suited for stock farming and ranching than for cultivation, though large areas of suitable farming soils also occur.

Potter County, on the High Plains, reaches northward into the rolling and broken lands of the Canadian River valley. In this general section of the Plains a very decided impetus to the development of intensive agriculture is being developed, especially along the lines of dairying, stock farming and small grain production. No detailed soil surveys have heretofore been made in this section of the State and it is believed that the survey of Potter County will afford a basis for aiding in the development of this important agricultural section.

Frio County lies in the southwestern part of the State, in an important section of the general region known as the Rio Grande Plain. Here considerable development of agriculture is taking place and much of the large ranch land holdings are being opened up for farming. Besides cotton and grain sorghums production, there appears to be some promise of an extension of vegetable and fruit production. Some irrigation is practiced, the water being obtained from wells, and larger irrigation projects are contemplated by impounding stream water.

Polk County lies in the East Texas Timber Country, where lumbering has long been the chief industry. Here the problem of utilizing the cut-over lands for agriculture is being considered and a soil survey will aid in planning for the adaptation and use of the soils.

The Trans-Pecos Area, comprising nine counties west of the Pecos River, was surveyed by reconnoissance, and at the same time a vegetation survey was made by the Range Botanist of the Division of Farm and Ranch Economics. This great area is devoted largely to ranching, though small areas of splendid valley soils are irrigated and used for the production of various crops, cotton and alfalfa being at present the most important. The material and information gathered in the survey is being prepared for publication.

During the year three soil surveyors have been regularly employed by the Texas Agricultural Experiment Station and three or more men assigned to this work have been maintained in the State by the Bureau of Chemistry and Soils. In addition to this, the Bureau of Chemistry and Soils had a party of four men in the State working in Van Zandt County for a period of several months during the winter season.

Some special work was done by the Division of Soil Survey in cooperation with the Division of Plant Pathology and Physiology in studying the

relation of soil types and soil characters to the development of cotton root rot.

BOTANY

The major activity of the Division of Botany has been continued toward the collection and cataloging of herbarium specimens representing the flora of the State. This work has progressed in a fairly satisfactory manner, but since the area to be covered is so large that the flora of such a varied nature as is found in Texas, a large part of the State remains unrepresented in our collection. The collection, preparation, and cataloging of specimens of plants are, however, only a means to an end; namely, as a check on our taxonomic knowledge of plants, or as a verification of their specific identity. It is necessary, therefore, to study the various plants found in Texas in their relation to economic agriculture, and in line with this objective the study of the flora of the Ranch Experiment Station, located in Sutton and Edwards Counties, was continued during the year.

An important line of endeavor of the Division of Botany is the propogation of shade and ornamental trees. In this work it was found that Live Oak, Chinese Pistache, and *Quercus serrata,* a very handsome oak raised from seed directly imported from China, have shown great hardiness. The most pleasing discovery is that hybrid oaks of Live Oak descent have shown themselves superior to their parent species in beauty, rapidity of growth, and hardiness. The remarkable character of these hybrids is the straight, vigorous growth of their shoots, in spite of the short, crooked growth of the Live Oak.

Of five species of cypress under trial, the Italian cypress is, perhaps, the most valuable, being adapted to a wide range of soil conditions and attains largest size and greatest age. The Deodar, Lebanon, and the Atlas cedars have shown themselves equally unadapted to the soils at College Station, but since the Deodar cedar planted on the grounds of Substation No. 2, Troup, has proved itself unexcelled for both hardiness and beauty, the other two may be expected to do equally well in that soil. The Maritime pine has flourished at College Station as though adapted to the type of soil found here. Although badly infected by the shoot-borer, it has continued to grow and repair the injuries instead of becoming stunted as did other species of pine.

During the latter part of May, 1928, 685 pot-grown seedling berry plants were planted on the new horticultural grounds. They are the remnants from the breeding that gave rise to the Nessberry and are made up of four separate hybrid races ranging from the second to the fourth generation from the original cross. Nessberry is present as pistil-parent in all of them, while as pollen parents, two are blackberries and the other two are from different varieties of raspberries. This choice of parentage was made with the object of correcting the picking qualities of the Nessberry, which in all other respects may claim superiority to any form of Rubus now cultivated in this State.

SWINE HUSBANDRY

Projects

1. Cottonseed Meal for Maintaining, Growing and Fattening Hogs; State and local funds; Fred Hale, leader.
2. A Study of the Effect of Adding Various Minerals to Rations for Fattening Hogs; Hatch and Sales funds; Fred Hale, leader.
3. Methods of Feeding and Feeding Value of Grain Sorghums for Swine; State and local funds; Fred Hale, leader.

Cottonseed Meal for Maintaining, Growing, and Fattening Hogs

The work under this project during the present year serves as a check on the work carried out during the previous year. The results secured indicate that not more than 9 per cent of cottonseed meal should be included in a ration for growing and fattening hogs. No pigs were lost from so-called "cottonseed meal poisoning" where 12 per cent of the ration was cottonseed meal, but the pigs did not look so thrifty and did not gain so uniformly and made smaller gains than did pigs receiving only 9 per cent or less of cottonseed meal in their rations. Some pigs died in lots where as much as 15 per cent of cottonseed meal was contained in the ration. The brood sows receiving only 9 per cent of cottonseed meal and 4 per cent of tankage in the ration stayed in better condition than the sows that received 15 per cent of cottonseed meal and no tankage in the ration, and their pigs grew more uniformly and made faster gains.

This work was planned to determine the optimum amount of cottonseed meal to include in brood sow rations and growing and fattening rations. Although larger amounts of cottonseed meal may be fed for short periods of time and to hogs of certain classes and weights, the results from the controlled tests included in this work, together with other work conducted by the Station for the past four years, show that it is not economical to include more than 9 per cent of cottonseed meal in the ration where the ration is fed indefinitely and to all classes of hogs. Furthermore, the results secured show that where the ration contains more than 12 per cent of cottonseed meal some of the pigs will die from the so-called "cottonseed meal poisoning," and pigs are likely to die from the same cause when as much as 15 per cent of cottonseed meal is contained in the ration even if they have access to green pastures, providing that the pigs are full fed.

A Study of the Effect of Adding Various Minerals to Rations for Fattening Hogs

No work has been done on this project during the last two years, the last report being that on page 56 of the Director's Annual Report for 1926.

Method of Feeding and the Feeding Value of Grain Sorghums for Swine

Work was begun on this project during the present year and is progressing satisfactorily. It is not possible, however, to report any definite results at this time, for the reason that the tests have not been completed. The objects of this work are:

1. To determine the relative value of the principal varieties of grain sorghum as compared with each other and with corn as a grain feed for growing and fattening pigs.
2. To determine the difference in value received by different methods of feeding the grain.

The tests that are now in progress in connection with this project are planned to solve the problem in connection with object No. 2.

The lots contain 10 pigs each, averaging 48.7 pounds, initial live weight. The first test will run for a period of 100 days, and is being conducted in a dry lot. The pigs are being fed individually and in groups of ten pigs to each lot. The feeds in the rations are fed in self-feeders, free-choice method. The feed that is to be soaked before feeding will necessarily have to be hand-fed, but in this case the pigs will be fed three times a day, so as to approximate self-feeding as far as possible. The lots are fed as follows:

Lot I—Ground corn and tankage.
Lot II—Dry milo heads and tankage.
Lot III—Soaked milo heads and tankage.
Lot IV—Dry threshed milo and tankage.
Lot V—Soaked threshed milo and tankage.
Lot VI—Ground threshed milo and tankage.
Lot VII—Dry threshed kafir and tankage.
Lot VIII—Ground threshed kafir and tankage.

DAIRY HUSBANDRY

Projects

1. Constructive Breeding of Dairy Cattle; State and local and cooperative (with the School of Agriculture) funds; ———————— and J. L. Lush, leaders.
2. Feeding Value of Cottonseed Hulls as a Roughage for Growing Dairy Heifers; dairy sales fund; J. L. Lush and Fred Hale, leaders.
3. The Use of Cottonseed Meal and Hulls as a Ration for Lactating Cows; dairy sales fund; J. L. Lush and Fred Hale, leaders.

Constructive Breeding of Dairy Cattle

Only a little progress was made this year in culling the cows for higher production, as several real good producers died through accident and disease, and this almost balanced the poor producers which were culled out on account of their low records. The policy of moderate line-breeding to the best cow among the purebreds and of mating the grades to the bull which is their closest relative has continued and a considerable portion of the heifers now growing up are line-bred in various degrees. They appear to be slightly superior in type to the

heifers which were produced in former years, but not enough have freshened to justify any conclusion regarding their producing ability. This breeding policy will be continued, avoiding as far as possible line-breeding to any bulls but line-breeding as closely as possible to the cows regarded as best in type and production.

Developments in this project have made it increasingly clear that a bull should not be judged by any one of a few daughters only. At the same time, it has become increasingly evident that it is highly important to find out very early in their lives which cows and bulls are good ones, if any line-breeding to them is to be attempted. There are many different ways in which an animal's breeding usefulness may be lost. For example, death by disease or accident, sterility or impotence, failure to produce calves of the desired sex, and so forth. If a breeder waits until his bull's daughters prove the bull's worth before concentrating the blood of that bull, he will necessarily wait until the bull is at least 5 years old, and usually 6 or 7 years. When the bull is that old the probability becomes high that something will happen to destroy his breeding usefulness very soon. This suggests the question of whether after all it may not be wiser to line-breed to bulls and cows which are thought, on the basis of pedigree and individual type and performance, to be good ones, but which have not yet had time to be proved by their daughters, than to wait until a considerable number of daughters freshen before doing any line-breeding directed toward those bulls or cows. The latter policy would be the sounder if we were sure that the proved sire or dam would be alive and fertile by the time the proving was accomplished, but we do not and can not have that assurance.

The work of this project is directed mainly toward two objects: first, finding surer ways of knowing which cows and bulls really are the best breeding individuals at as early ages as possible, and, second, studying the effects of various degrees of inbreeding.

Under the first object, this year's results have emphasized the fact that a production record is more accurate than most judges in picking out the good cows, but that is not perfect. An average of two records is much more accurate than one record alone, and an average of three records is still more accurate. A specific study of this point is under way at present.

Feeding Value of Cottonseed Hulls as a Roughage for Growing Dairy Heifers

One group of heifers receives no dry roughage except cottonseed hulls. Another group receives Bermuda hay. Both groups receive grain and silage when available and pasture when available. The heifers are divided into groups when three months old and remain in their group, as far as roughage is concerned, until they freshen. A very large number of weights and measurements are being taken and detailed records are being kept. No detailed analysis of these data has yet been

made. Observation indicates that the heifers receiving only hulls are not quite as thrifty nor as well-developed as the others. All heifers were judged and scored individually in May, 1928, keeping in mind as ideal a useful, practical dairy cow with a small amount of attention to special breed type. The average score of the 18 heifers receiving hulls was 66.3 per cent and of the 21 heifers receiving hay was 73.0 per cent. The difference between the two averages was 6.8 $\pm$ 2.1 per cent, and, therefore, seems to give statistical support to the observation that the hull-fed heifers did not appear as thrifty or well-developed as the hay-fed heifers. Further analysis of these records is expected to be made during the coming year. Our tentative conclusion is that dairy heifers need at least a small amount of a good grade of grass hay. Hulls are a useful roughage and offer a very cheap one, but they are not suitable for the entire dry roughage part of the ration. They need to be at least supplemented with some good hay.

The Use of Cottonseed Meal and Hulls as a Ration for Lactating Cows

Cottonseed meal as the sole concentrate for lactating cows has not yet produced apparent harmful results, although very large quantities have been fed for nearly two years, ranging up to an upper extreme of 20 pounds per day, which was fed to one high-producing cow for one 28-day period. All cows have received pasture when available, silage when available, and water and salt and limestone at all times. The detailed records of production, weights and feed consumption are being studied, but this study has not yet progressed far enough to justify conclusions. There has been no great difference between the production of cows receiving cottonseed meal as the sole concentrate and those receiving a more balanced ration. At the usual prices prevailing in Texas, it is not economical to feed much more cottonseed meal than is necessary to balance the ration, but our results to date indicate that even excessive quantities of cottonseed meal may have no injurious effect upon the cows when they also have access to pasture and silage, as is the case on most practical dairy farms. Certainly there does not appear to be much reason to fear ill effects from the use of cottonseed meal to balance the ration under such conditions. For cows kept in dry lots and fed heavily with rations very high in protein it seems wise and conservative to use some other feeds along with cottonseed meal to furnish a considerable part of the protein of the ration.

POULTRY HUSBANDRY

Projects

1. Breeding as Affecting Egg Production; State and local funds; R. M. Sherwood, leader.
2. Comparison of the Feeding Value of Protein from Vegetable Sources with Protein from Animal Sources for Laying Hens; State and local funds; R. M. Sherwood, leader.

3. Comparison of Various Feed for Young Chickens; State and local funds; R. M. Sherwood, leader.
4. Studies of Variation in Hatching Quality of Eggs; State and local funds; R. M. Sherwod, leader.

Breeding as Affecting Egg Production

The work under this project this year is a continuation of that carried on the previous year. The progeny of Cocks 113, 114, 115, and 116, were trap-nested during the year. Cock No. 116 is the outstanding breeder, none of his pullets laying less than 100 eggs up to October 1, and 58 per cent of them laying over 180 eggs. Pullets hatched in the spring of 1927, are being trap-nested this year, but their records are not complete. Other pullets which were hatched in the spring of 1928 are being held and will be trap-nested the coming year. In addition to breeding White Leghorns for increased egg production, breeding work is being done using White Rocks and Barred Rocks in an endeavor to establish a White Rock high-egg producing strain.

Additional studies were made on the data already collected to determine the effect of external body characters on egg-production. An attempt was made to develop a production score card. This work is given in detail in Contribution No. 397 of this Station, entitled "Construction of Score Card for Judging for Egg-production," published in Poultry Science, Volume VII, No. 6, September, 1928. The Score Cards developed are given in the following table:

SCORE CARDS FOR JUDGING HENS FOR EGG-PRODUCTION

	From Coefficients of Determination		From Betas	
	Sample 96 Hens	Sample 100 Hens	Sample 96 Hens	Sample 100 Hens
Weight	1.20	12.45	2.50	22.63
Color of shank	22.25	23.83	17.47	17.22
Handling quality	1.32	1.38	1.12	1.75
Capacity	7.15	19.60	7.10	20.56
Molt	30.01	.75	24.45	1.03
Length of back	6.86	1.49	13.08	2.79
Width of back	3.88	3.13	8.99	4.49
Depth of body in front	27.34	37.35	25.29	29.54

It will be noted that the score cards made from the coefficient of determination are not radically different from the score cards made from the Betas. The score cards for the one lot of hens are radically different from the score cards for the other lot. Even though the multiple correlation coefficients for the two samples are similar in magnitude, which indicates that the samples are drawn from similar populations, the factors have contributed so differently that neither score card made for one group of these hens can be used very successfully with the other group.

Comparison of the Value of Protein from Vegetable Sources with Protein from Animal Sources When Fed to Laying Hens

In this project two distinct lines of work are under way. The first is the study of the effect of various feeds on the storage quality of eggs, and the other is a study of the value of white corn and yellow corn, milo and kafir, as a feed for laying hens and also the study of yellow corn as a carrier of vitamin "A." Texas Station Bulletin No. 376, entitled "The Effect of Various Rations on the Storage Quality of Eggs," gives a report of the analysis of the data collected the first year on the first part of this project.

During the spring of 1928, 40 hens were fed two gelatin capsules daily containing varying amounts of cottonseed meal, from one to twelve grams. As the amount of cottonseed meal would be decreased in the capsules the amount of meat scrap containing the equivalent amount of protein was used in its place. Other hens received cottonseed meal with a low fat content, and still others received meat scrap with crude cottonseed oil added. Another lot received green feed as compared with no green feed. The eggs from these hens are in storage and will be studied during the fall of 1928, with a color analyzer and viscosmeter. Chemical analyses will also be made.

Comparison of Various Feeds for Young Chickens

This experiment lasted eight weeks, from June 1, 1928, to July 7, 1928. When the chicks were three days old they were divided into nine lots of 113 chicks each and started on the experiment. The experiment had for its object the testing of the value of various floor materials and feeds and their effect on health and growth of chicks. The following table gives the rations for the 1st, 2nd, 3rd, 7th, and 8th weeks, together with the description of the floor covering. During the 4th and 5th weeks, lots 1, 2, 3, 4, 8, and 9 received a ration of dried milk, 40 pounds, yellow corn meal, 40 pounds, and wheat gray shorts, 20 pounds. Lots 5 and 6 had their normal ration except that this was fermented for from 12 to 24 hours during the first three days of the 4th week. Lot 5 also received a commercial coccidiosis remedy. Lot 7 received the regular ration except that a commercial coccidiosis remedy was added during the first three days of the 4th week. Lot 9 received chloride of lime in their drinking water. This evidently was fed too strong, as judged by the mortality and slow growth of these chicks.

At the beginning of the 4th week, when coccidiosis broke out in these lots, the chicks in Lots 5, 6, 7, 8, and 9 were moved about so that one-fifth of the chicks in each pen were placed in each of the other pens. This was done to allow for any differences that may have crept into these lots during the first weeks of this experiment.

All of the chicks that received the milk ration to check coccidiosis made satisfactory gains and had a remarkably low mortality, except Lot 9, which was possibly weakened by the use of too strong a solution of chloride of lime in their drinking water. Lot 3, on hardware cloth, did

remarkably well. The lots receiving commercial coccidiosis remedies did not do as well as the milk-fed birds.

RATIONS IN POUNDS FOR NINE LOTS OF CHICKS FOR 1ST, 2ND, 3RD, 7TH, AND 8TH WEEKS, AND DESCRIPTION OF FLOOR COVERINGS

Feeds	Lot Numbers								
	1	2	3	4	5	6	7	8	9
Yellow corn meal	65	65	65	65	60	60	60	60	60
Wheat gray shorts	20	20	20	20	20	20	20	20	20
Meal scrap	5	5	5	5					
Cottonseed meal					10	10	10	10	10
Alfalfa leaf meal	5	5	5	5	5	5	5	5	5
Bone meal	2	2	2	2	2	2	2	2	2
Oyster shells	2	2	2	2	2	2	2	2	2
Salt	1	1	1	1	1	1	1	1	1
Floor covering	Straw & Ag. Lime	Straw & Ch. Lime	Hard-ware cloth	Straw	Straw and chloride of lime on floor				

Studies of Variation in Hatching Quality of Eggs

The work under this project was continued during the year. Data were secured from 130 individual hens and seven different flocks. The eggs from individual hens ranged in hatchability from 0.0 per cent to 100 per cent. The seven different flocks ranged from 37 per cent to 65 per cent of the total eggs set. The average hatch of the 29,185 eggs set this year was 53.8 per cent as compared with 65.7 per cent the last year. Seasonal conditions, flock management, handling conditions, breeds of fowls, and individuality are factors which cause differences in hatchability of eggs under like conditions.

RURAL HOME RESEARCH

Projects

1. The Adequacy of the Diet of Texas School Children; Purnell fund; Jessie Whitacre, leader.
2. The Influence of Texas Sunlight on the Durability and Color of Cotton Fabrics; Purnell fund; Mary Anna Grimes, leader.
3. Growth in Height and Weight of Texas School Children; Purnell fund; Jessie Whitacre and Emma E. Sumner, leaders.

The Adequacy of the Diet of Texas School Children

The object of this project is to determine the extent to which the diet of Texas school children conforms to present-day dietary standards and the correlation which may exist between the type of diet and two health indices, namely, height-weight-age status and quality of teeth.

The findings of this study will guide to the wiser selection and planning of future intensive studies of various dietary factors. They should be of service also in connection with health programs conducted by schools and other educational agencies.

The project is proceeding along two distinct lines: (1) a general, qualitative study of the character of the diet of a rather large number of representative school children in each of six well differentiated regions of Texas, and (2) an intensive, quantitative study within each region of a smaller number of children who differ in age and degree of physical well-being. Three race groups—white, Mexican, and negro—are included in the study.

The qualitative picture of the diet is being secured from written records which the children are asked to keep on forms provided them for eight consecutive days at two seasons of the year, and from a list of foods which they check to show their appetites for each food and their eating habits. Thus far, with the aid of cooperating schools, the collection of two seasons' records has been completed for each of approximately 1,000 white school children in each of three counties, Hidalgo, Jefferson, and Brazos, and for 250 Mexican pupils in Hidalgo County. Over 500 negro children in Jefferson County schools and 350 in Brazos County have cooperated for one season. Their second season's records will be completed within the coming school year. The weight and height, both standing and sitting, have been ascertained for each child within each period of record keeping. Quality of teeth has been determined by a dentist's examination. Work on the scoring of the dietary records, and the tabulation and interpretation of the data is in progress.

It is hoped that work on the intensive phase of the project will be started within the coming year. The plan is to weigh the food eaten for four consecutive days by each of the children selected; to take samples of the foods for which, later, calorie values will be determined by means of the oxy-calorimeter, and with the cooperation of the Division of Chemistry to have these food samples analyzed for nitrogen, calcium, and phosphorus. These data will be interpreted for each child in conjunction with his state of well-being, which it is anticipated will be determined with the aid of a physician's cooperation.

The Influence of Texas Sunlight on the Durability and Color of Cotton Fabrics

The object of this study is to determine the extent to which the durability and color of cotton fabrics are altered by exposure to sunlight.

Previous work limited in scope and done elsewhere, has shown that the nature of the light and the conditions of the atmosphere may have some effect upon the durability and color of fabrics, but the extent of these influences largely remains to be determined with precision. The relative intensity and long duration of Texas sunlight, together with the varying different climatic conditions in the different sections of the State make such a study of particular interest in Texas, where cotton growing is a primary industry.

The facts brought to light by such a study should prove of direct value to the consumer of cotton fabrics, especially with reference to the best methods of drying cottons; the best conditions for storage and

general care of cotton clothing; the colors most fast to light and the advisability of purchasing cotton fabrics guaranteed fast colors in respect to durability, color, and cost. The findings may also be significant for the cotton grower in throwing light upon the probable deterioration of the cotton fiber occuring between the opening of the boll and harvesting.

The 57 fabrics used in this project include white and five colors in each of the following: meadow lane cloth, pamico cloth, everfast suiting, everfast gingham, year round zephyr, nainsook, broadcloth, voile; five colors in chambray, and two each of bleached and unbleached muslin.

Each fabric, previous to exposure, is being analyzed for: width, finish, cost per unit measure, color, thread count, thread twist, elongation and breaking strength of fabric and yarn, conditioned weight, and bursting strength. All tests are being made with suitable precision apparatus such as is approved by the Bureau of Standards and leading textile laboratories. Each fabric will be exposed to light for varying known periods of time in different seasons of the year. After exposure each fabric will be tested again for color and strength, thus ascertaining any change produced by Texas light. At present the effect of light on the durability and color of cotton fabrics is being studied at College Station. At a later date, the same fabrics may be exposed to sunlight in other regions of the State.

Growth in Height and Weight of Texas School Children

This project proposes to determine the rate of growth in terms of height and weight through all seasons of the year for white, Mexican and negro school children of Texas.

Among previous investigations of children's growth carried on in the United States, few have given special attention to the influence of race, and results disagree on the point of seasonal variation. The height-weight-age tables (Baldwin and Wood's) most used at the present time are regarded as but tentative standards for white children, and there is question as to the propriety of their use for other race groups. Data secured by this study should aid in a more rational use of accepted height-weight-age tables and contribute material toward the construction of tables for Mexican and negro children, if the need for such tables exists.

The plan is to secure through the cooperation of interested schools, individual records for 500 to 1,000 school children of each racial group. The project will extend over a period of two to five years of time. Data for each pupil will include weight taken under as uniform conditions as possible at intervals of a month; height, both standing and sitting, taken two or three times a year; width of shoulders and hips, to provide an index to body build; race and nationality; nutrition rating; parents' occupation; history of illness or physical defect preceding or during the time of study; foods eaten for one to three days at each weighing period. Daily weather records will be kept for the time of the study.

It is planned to begin collection of data for this project soon after the opening of schools this fall.

APICULTURE

The apicultural work previously carried on under the Division of Entomology was set up as a separate Division of Apiculture at the beginning of the fiscal year with headquarters at the State Apicultural Research Laboratory located near San Antonio. The State Apicultural Research Laboratory is further supported by Research Queen Out Yards located at Dilley, Frio County, Roxton, Lamar County, and Seguin, Guadalupe County, with a Research Queen Yard at San Antonio.

The spring count of bees in 1928 was 68 colonies at the main laboratory, 52 colonies at Dilley, and 44 colonies at Roxton. The colonies at the Laboratory furnished bees and comb for 50 breeding colonies at the Queen Yard. The honey production was 4,200 pounds.

The work of the Division of Apiculture carried on under general project entitled "Beekeeping Investigations," includes studies relating to the distribution of bees in the State, their economic importance, breeding problems, problems in nutrition, the behavior of bees, bee disorders, equipment, and honey products.

Records obtained in the studies of the behavior of bees indicate that bees become inactive as soon as the temperature reaches 94 degrees F. and a relative humidity of below 50 degrees. There seems to be no correlation between the local weather conditions and the honey flow; there appears to be a definite correlation between the total amount of stores gathered and the amount of honey that can be removed; there appears to be definite correlation between the amount of honey stored by a related strain of bees and weather conditions; and a definite correlation between the amount of honey stored and the percentage of exposure of hives to sunlight. The results obtained thus far are of such character as to emphasize the importance of further studies along this line.

In the study of bee nutrition, those shrubs which are high-nectar-producing and which have made Southwest Texas the great commercial honey center are being grown with a view to obtaining a knowledge of their life history and adaptation to cultivation. A large number of honey plants are being tested, with the object of finding plants high in nectar production which will maintain themselves on uncultivated ground and without much attention.

A study has been made of the poisoning of bees from cotton which has been sprayed or dusted with material for the killing of insects. Notes have been compiled during the past five years, and from the evidence at hand it is not possible to outline a mode of procedure to avoid this poisoning. It appears that bees have been killed only where poison was applied to the cotton together with a sweet adhesive mixture or where honey-dew was present upon the leaves.

The weather during the year was very advantageous to the honey

bees and to the growing of honey plants. The rapidly growing collection of living honey plants is making a very noticeable display.

FEED CONTROL SERVICE

During the past year a thorough system of inspection of commercial feeding stuffs sold in the State has been maintained. Six inspectors have been on the road each working day and have visited feed dealers, feed manufacturers and consumers in order to secure official samples of feed for analysis, weigh packages of feed to prevent the practice of selling short-weight packages of feeds and detect any other violations of the law which might exist. Each inspector mails a report of his activities daily and files in the office at College Station an itinerary which is subject to revision if considered advisable. This year the inspectors have traveled 73,624 miles in the performance of their official duties, which indicates that the inspection has been more thorough during the past year than in the preceding year.

During the past year the inspectors of the Feed Control Service secured 2,624 official samples, which were subjected to chemical analysis and microscopical examination. In addition to these, 319 registration samples and 58 special samples were analyzed, making a total of 3,001 samples analyzed during the time covered by this report. Thirty-one of the 58 special samples were taken by feed dealers and consumers according to instructions from this office and were, therefore, considered as official. Cooperation with the Bureau of Chemistry of the United States Department of Agriculture was continued during the year, and by means of this cooperation the Feed Control Service was in position to control interstate shipments of feed and protect Texas purchasers who bought feeding stuffs manufactured in other States.

The system of reporting the results of inspection continues the same as in past years. Results are reported to manufacturers, dealers, and consumers in order that all parties interested may know to what extent the provisions of the feed control law are being complied with. When the analysis of a sample or the report of the inspector shows a particular lot of feed to be misbranded or adulterated, the dealer is notified at once and advised to remove it from sale pending a satisfactory adjustment. In this respect all retailers and dealers have given their hearty cooperation.

During the year covered by this report feed dealers have been advised to remove from sale 535 shipments of feeds, manufactured by 301 different firms, totaling 3,347,080 pounds. This feed was being offered for sale in violation of some provision of the feed law of this State although in many instances the violation was of minor importance. Untagged shipments were properly tagged; improperly tagged shipments were relabeled and the sale of feed below guarantee was in practically all instances adjusted by the manufacturer paying a refund to dealers when the deficiency was sufficient to warrant such action. In all cases whenever a refund was paid dealers were advised to prorate

to their customers the amount of the refund insofar as possible, so that the ultimate consumer might receive its benefit. Twenty-two complaints were filed during the year, which were settled out of court by the defendants paying the fines and docket costs. Four cases which had been pending for some time were dismissed, and one defendant was tried and found not guilty.

A representative of the Division has attended conventions of the Association of Food, Feed and Drug Officials of the South Central States and the Texas Cottonseed Crushers' Association. The Chief of the Division has held important offices in the Association of Feed Control Officials of the United States and in the Association of Food, Feed and Drug Officials of the South Central States.

As has been the custom in previous years, two semi-annual conferences with the feed inspectors were held during the year. These conferences serve also as a school of instruction and as an opportunity for the solution of many problems which arise in the feed inspection work. These conferences were held in College Station, one in September, 1927, and the other in April, 1928.

AGRICULTURAL ENGINEERING

During the year, cooperation was continued with the Department of Agricultural Engineering, School of Agriculture, Agricultural and Mechanical College of Texas, in work being carried on in connection with several projects coming within the field of Agricultural Engineering. The work on Project No. 211, "A Study of the Cotton Dropping Device," was continued during the year, and considerable data have been compiled for study.

A project dealing with the mechanical harvesting of cotton is being carried on in cooperation with the Division of Agronomy and Texas Substation No. 8, Lubbock. A manuscript giving a progress report of the work on this project has been prepared for publication.

The Division of Agricultural Engineering has cooperated with the Division of Farm and Ranch Economics in the work which resulted in the publication of Texas Station Bulletin No. 373, "Harvesting Grain with the Combine Harvester-Thresher in Texas."

Cooperation was continued in connection with Project No. 209, "Run-off Water Losses in Relation to Crop Production," which project is carried in the Division of Agronomy and reported on in the Division of Agronomy report included herewith. This division is concerned mainly with solving the many agricultural engineering problems in connection with the work on this project, which has to do with conserving rainfall and reducing the amount of water turned into our streams and the prevention of erosion of soil.

MAIN STATION FARM

The Main Station Farm is the main field laboratory for the Division of Agronomy, at College Station. It is located on the lands of the

Agricultural and Mechanical College of Texas, Brazos County, adjacent to and west of the Southern Pacific and Missouri Pacific Railways, in latitude 31 degrees 39 minutes north and longitude 26 degrees 26 minutes west, with an elevation of 308 feet above sea-level.

Ginning Studies

The question of ginning of cotton in its relation to grade and to the ultimate spinning value of the lint is of importance, and should be well understood. Accordingly, a study of the ginning of cotton in relation to the market value and spinning value of the lint was begun in 1926 and continued during the ginning season of 1927 as one of the projects on the Main Station Farm. This work includes studies on the effect of speed of the saws, condition of roll tightness, and the effect of the use and non-use of the cleaning apparatus. A two-stand Murry Air-Blast Gin is used in these studies. This gin also serves the additional purpose of ginning pure seed for farmers.

Rotations, Fertilizer, and Soil Improvement

Two tests were conducted in 1927, one with a three-year rotation of oats, cotton, and corn, and the other a four-year rotation with cotton, corn, cowpeas, and oats, together with continuous cotton and continuous corn.

The fertilizer work in the three-year rotation, which is part of a rather comprehensive experiment with fertilizers conducted at several points in the eastern part of the State, was begun in 1927. In these studies a 12-4-4 fertilizer at the rate of 400 pounds to the acre is used as a standard treatment, and each element—nitrogen, phosphoric acid, and potash—is varied in turn, while the other two are kept constant. The 12-4-4 fertilizer is used also at the rates of 200, 400, 600, and 800 pounds to the acre. In 1927 the plats receiving manure treatments and those receiving a 12-8-8 fertilizer were the high producers of both corn and cotton.

The four-year rotation test consists of cotton, cowpeas, corn, and oats, in comparison with continuous cotton and continuous corn. Seven different fertilizer treatments are used in both the rotated and non-rotated areas. These treatments consist of superphosphate; superphosphate and cottonseed meal; superphosphate and manure; rock phosphate and manure; manure alone, and removal of crop residues on plats receiving no treatment. The results in 1927 showed a slight increase in the non-rotated cotton over the cotton in the rotation, while with the corn, the corn in rotation outyielded the corn planted continuously on the same land each year.

Sulphur Studies

These studies were continued from the previous year with cotton and cowpeas, using sulphur at the rates of 100 and 200 pounds to the acre. In 1927, there was practically no difference in the yield of cotton on

plats which received no treatment and the yield of those receiving 100 and 200 pounds of superphosphate. For the two years there was practically no difference in the yield of the 100 pound treatment and the untreated plats, while the yield of the 200-pound treatment was below the yield of the non-treated plats.

In 1927, the plats receiving 100 pounds of sulphur produced 129 pounds more of cowpea hay to the acre than the non-treated plats, and for the two years, a gain of 34 pounds. The plat with an application of 200 pounds of sulphur to the acre made a gain of 186 pounds of cowpea hay in 1927, and for the two years average a gain of 139 pounds to the acre.

Variety Test of Cotton

This test included 22 varieties in 1927, in quadruplicate plantings. Cook made the highest yield, 219 pounds of lint to the acre. New Boykin was second high-yielder with 213 pounds of lint to the acre. This variety also made the highest yield, 256 pounds of lint to the acre, for the last five years. The results of the variety test over a period of years show that in general Mebane or strains of Mebane (such as Mebane, Kasch, New Boykin, and Cliett), along with Truitt, Lone Star, Acala, and Rowden are good varieties of cotton for this part of Texas. Texas Station Bulletin No. 369, entitled "Varieties of Cotton for East-Central Texas," gives the results of this test during the fifteen years, 1912-1926, inclusive.

Variety Date Test of Corn

This test, embracing eleven varieties and three dates of planting, has been conducted since 1918. In 1927, Oklahoma White Wonder made the largest yield, 30.8 bushels to the acre of shelled corn, as an average of all dates of planting. For the nine-year period, 1918 to 1927, Ferguson's Yellow Dent made the highest average yield, 27.7 bushels to the acre. The early planting made larger yields than either the medium or the late planting. The highest yielder of the early planting was Hastings' Prolific, with 37.8 bushels to the acre. In the medium date Oklahoma White Wonder ranked first, with 33.1 bushels to the acre, and in the late planting Thomas made the highest yield, 26 bushels to the acre.

Variety Test of Oats

In this test, consisting of nine varieties planted in duplicate, Commercial Oat made the largest average yield, 22.5 bushels of cleaned oats to the acre. For the ten-year period, 1917 to 1927, Red Rustproof, T. S. No. 1415, was the highest yielders, with an average yield of 31.8 bushels to the acre, while Red Rustproof, T. S. No. 1118, ranked next with a yield of 30.3 bushels.

Variety Test of Peanuts

Seven varieties of peanuts were planted in triplicate: Virginia Bunch, Valencia, Tennessee Red, Macspan, Virginia Runner, Carolina Runner, and Little Spanish. Macspan made the largest yield, 26.6 bushels of nuts to the acre; Carolina Runner was second, with 11.8 bushels; and Virginia Bunch third with a yield of 8 bushels to the acre. The Macspan is a selection of the Little Spanish, and both of these are well adapted to soil and climatic conditions in Texas. The large-podded varieties are low yielders at this Station.

Peanut Improvement

Improvement of the Macspan peanut by selection was continued in 1927. This selection of Little Spanish produced nuts which were 18.69 per cent larger than the commercial Little Spanish peanut. It also produced on the average 23.7 per cent larger yields of nuts than the Little Spanish variety. The results of this work have been published in Texas Station Bulletin No. 381, entitled, "Peanuts in Texas."

Cowpeas

Groit and Brabham cowpeas continue to be the best variety for both forage and seed yields, while Chinese Red and Red Wonder are the earliest to mature and are high yielders of seed.

Soybeans

Four varieties of soybeans were planted in 1927. With the exception of the Laredo, these were destroyed by Jack Rabbits. For some reason the rabbits do not like the Laredo variety. Similar results were obtained in 1926.

Corn and cotton breeding work was conducted on the Main Station Farm in connection with the Division of Agronomy, and is reported under the work of that Division.

PUBLICATIONS

The Division of Publications has continued during the year to supervise the work of the Publications Committee, through which Committee all publications must pass. This Division also has charge of the necessary work in editing and proof-reading manuscripts and subsequently the distribution of the printed publications to the best advantage.

A total of 418,549 copies of Station publications were distributed during the year, including bulletins, circulars, and press bulletins, being a gain of 20,886 for all publications sent out during the year. While there was a slight increase in the number of copies of publications sent out, the mailing list had decreased slightly—from 69,402 names at the close of last year, to 66,467 names at the close of this year. The major effort at this time is being centered around the distribution of

publications to definite requests, since it is believed that a more satisfactory distribution of publications will be secured in this way than by distributions prompted by a large mailing list.

Attention is called to the fact that while the total number of publications issued this year was slightly less than those issued the previous year, the total number of pages for each publication has exceeded that of last year by 3.8 pages, and the subjects covered in these publications have been of timely interest to farmers and the citizenship in general. It is also gratifying to state that the publications of this Station have been well received by farmers and others, and are exerting marked influence in stimulating increased interest along all lines of agricultural research.

The following is a tabular statement of the 18 bulletins, four circulars, and one annual report issued during the fiscal year:

Number	Title	No. of Pages	No. Copies in Edition
	Total	884	322,000
Bulletin No.			
366	Varieties of Cotton in the Red Prairies of Northwest Texas	19	12,000
367	Activities of Livestock on the Range	47	16,000
368	Commercial Fertilizers in 1926-27 and Their Use	61	7,500
369	Varieties of Cotton for East Central Texas	52	14,000
370	Commercial Feeding Stuffs, September 1, 1926, to August 31, 1927	132	9,000
371	The Effect of Salt Water on Rice	10	6,000
372	Digestibility and Production Coefficients of Poultry Feeds	24	5,500
373	Harvesting Grain with a Combined Harvester-Thresher in Northwest Texas	24	16,000
374	A Chemical Study of Varieties of Cotton Seed	19	6,000
375	The Soils of Bowie, Denton, Freestone, and Red River Counties	48	7,500
376	The Effect of Various Rations on the Storage Quality of Eggs	12	15,000
377	Hibernation of the Cotton Flea Hopper	26	12,000
378	Services, Facilities, and Costs of Marketing Vegetables in the Lower Rio Grande Valley of Texas	39	11,000
379	Grain Sorghums vs. Corn for Fattening Lambs, Fourth and Fifth Experiments	52	15,000
380	Investigations on Control of the Cotton Flea Hopper in 1927	27	9,000
381	Peanuts in Texas	23	15,000
382	Bagworms of Texas	36	8,000
383	Relation of Farm Prices to Quality of Cotton	29	9,000
Circular No.			
48	The Production of Clean Milk	25	12,500
49	Abstracts of Bulletins 347-365, and Circulars 43-47	22	75,000
50	Second Biennial Report of Apiary Inspection, 1925-1927	11	11,000
51	Texas Agricultural Outlook for 1928	20	15,000
	Annual Report, 40th (1926-27)	126	15,000

In addition to the research bulletins and circulars printed by the Station, the workers have prepared and submitted for publication in scientific journals the following contributions on various subjects coming within the field of their investigations:

Mangelsdorf, P. C. The Effect of a Lethal Factor on the Heterozygote in Maize. Journal of Heredity, V. XIX, No. 3, pp. 123-131, March, 1928.

Conner, A. B. Cotton Production Methods in the Southwest. Journal of the American Society of Agronomy, V. XX, No. 3, pp. 249-253, March, 1928.
Rea, H. E. Asexual Reproduction of Cotton. Journal of Heredity, V. XIX, No. 8, p. 357, August, 1928.
Lush, J. L., Christensen, F. W., Wilson, C. V., and Black W. H. The Accuracy of Cattle Weights. Journal of Agricultural Research, V. XXVI, No. 6, pp. 551-580, March 15, 1928.
Karper, R. E. Longevity and Viability of Kafir Seed. Journal of the American Society of Agronomy, V. XX, No. 5, p. 527, May, 1928.
Gabbard, L. P. Effect of Large-Scale Production on Cotton Growing in Texas. Journal of Farm Economics, V. X. No. 2, pp. 211-221, April, 1928.
Rea, H. E. Variability in Staple Length of Some Commercial Varieties of Cotton. Journal of the American Society of Agronomy, V. XX, No. 7, pp. 703-709, July, 1928.
Lush, J. L. Practices and Problems in Cross-Breeding Cattle in the Coastal Plains of Texas. Proceedings of the American Society of Animal Production, November 25-27, p. 58.
Jones, J. M., and Lush, J. L. A Statistical Interpretation of Some Texas Lamb Feeding Data. Proceedings of the American Society of Animal Production, November 25-27, p. 167.
Sherwood, Ross M., and Godbey, C. B. Construction of Score Card for Judging for Egg-Production, Poultry Science, V. VII, No. 6, September, 1928.
Rea, H. E. Location of "Motes" in Upland Cotton. Journal of the American Society of Agronomy, V. XX, No. 7, pp. 703-709, July, 1928.

In addition to this list of contributions, the workers have prepared a number of popular articles for publication in the agricultural press and for delivery over the radio, on subjects of timely interest to farmers and to the citizenship in general.

SUBSTATIONS

The size of Texas, its diversity of soils, and its varying climatic conditions provide several well-defined agricultural regions, within which agricultural problems can best be studied through substations, or field laboratories, where the work can be carried out under the conditions existing where the problem is encountered. The substation, while serving in a local way, is essentially a laboratory for the study of regional problems. Its work may be of such a character as to extend beyond the confines of the agricultural region served, and it is desirable that certain fundamental work of this character be done at each of the substations in addition to the study of problems of regional and local significance. The soil erosion and water conservation work at the Station near Spur, the cotton root rot work emphasized at the Blackland Station near Temple, and the work with sheep and goats at the Ranch Experiment Station near Sonora are striking examples of work of the greatest importance to the respective regions served, yet having a wide application to other regions as well.

The work at the substations is organized and coordinated with the work of the several divisions of the Main Station so that the substations are, in fact, experimental field laboratories for the study of outstanding problems of importance in the different sections of the State.

The following is a brief statement of the work of each of the substations for the year:

Substation No. 1, Beeville

Substation No. 1 is located 5.5 miles northeast of Beeville, Bee County, and is adjacent to the Galveston, Harrisburg & San Antonio Railway; latitude 28 degrees north and longitude 79 degrees west; and with an elevation of 240 feet above sea-level. The average annual rainfall recorded over a period of 25 years is 29.87 inches. The Station comprises 151.5 acres, of which 104 are in cultivation, 28 in pasture, 3.5 in farmstead, 6 in roads and ditches, and 10 in wasteland. This Station is located in an agricultural region which can be designated as interior black prairie lands, principally Victoria and Goliad series of soils.

The major activities of the Station during the year have consisted of work with field crops, such as cotton, corn, grain sorghums, and broomcorn; legumes, such as peanuts, cowpeas, and clovers; grasses; horticultural crops, such as oranges, grapefruit, Meyer lemon, peaches, grapes and figs.

Cotton: The early season was favorable for cotton production, but high winds and extremely dry weather in late June and in July caused cotton to shed all except the earliest fruit. Bolls opened prematurely, causing injury to the staple and reduction in yields. No insect damage occurred this season.

In a variety test of nineteen varieties of cotton the medium to short staple varieties, including Sunshine, Ferguson 406, New Boykin, Rowden, and Mebane 804, gave the best yields. Of the varieties with longer staple, Delfos was the highest yielder in the test. All staple was rather weak and short because of dry weather.

Corn: The past year was very unfavorable to the production of corn. Crops came to a good stand and made good early growth, but the drouth in May, accompanied by chinchbugs, almost ruined the crop before the rains came in early June. After these rains, corn recovered, but was again injured by severe winds and drouth before it was mature.

In a comparison of 15 varieties of corn, Chisholm lead in yield, with 15.61 bushels to the acre, followed very closely by Reuter's Golden Dent, Surcropper, Oklahoma White Wonder, Reece's Drouth Resister, Mexican June, Horton, and Thomas, in the order given. Tuxpan was the lowest yielding variety.

Results secured from a date of planting of corn conducted during the past year indicate that March 15 is the best time to plant corn in this section. This is in accord with the general average over a period of years.

Pure-line breeding work with corn was continued this year. One hundred strains of Thomas, 100 strains of Surcropper, and 10 strains of Yellow Dent were carried into the second year. All strains were selfed and seed secured for the third year. Several undesirable characters have been found, and attempts will be made to eliminate them.

Grain Sorghums: Sixteen varieties were included in a variety date test of grain sorghums. Weights are not yet available, but general observations indicate that Blackhul kafir and Hegari continue to lead in feed value for this section. The medium early date of planting, March 21, seems best for Blackhul kafir and similar types. March 21 planting of Hegari gave best results this season, probably because the later plantings were injured by drouth. Hegari planted by May stood in the field all summer with very little growth, but headed out and made a good crop of seed. Heads were bagged on each variety of grain sorghum in order to maintain and increase purity in strains for planting. Several hundred pounds of pure-line Hegari and Texas Blackhul kafir are on hand for distribution to farmers of Southwest Texas.

Broom Corn: In a variety test of six varieties of broom corn, Miller Dwarf apparently has maintained its standing as being the best adapted and most profitable variety to grow in this section. Results secured from a seeding rate and date test of broom corn, including six rates and two dates, indicate that the 15-inch spacing gave the best quality of brush.

Legumes: In a variety test of 13 varieties of cowpeas conducted during the past year, Chinese Red and Chinese Whippoorwill outyielded all other varieties in hay production. The more viny and later varieties were injured by drouth. Only a few of the earliest varieties, including Chinese Red, Chinese Whippoorwill, and Cream peas produced seed. The two Chinese varieties gave good yields. Bur clover has continued to give excellent results as an orchard cover crop, and is proving profitable for winter grazing on Bermuda and other permanent pastures. *Melilotus indica* again made a good growth in the orchards of this Station. *Melilotus alba* was killed out by hot, dry weather during the summer.

Angleton Grass: Angleton grass continues to stand the drouth and grow reasonably well under field conditions in this section. Some roots transplanted to pasture land came through the summer alive, even though the pasture was grazed very closely. This grass is growing rapidly during the late summer.

Fertilizers: The Fertilizer experiments included tests of different fertilizer analyses. The application of 400 pounds to the acre of a 12-4-4 fertilizer increased the yield of cotton 11½ per cent, but the value of the increase produced by the fertilizer was not sufficient to pay the cost of the fertilizers. None of these fertilizers gave an appreciable increase in the yield of corn. Results continue to show that no increase in yield was secured where sulphur was used as a fertilizer for cotton.

Fruits: Horticultural work at this Station largely along the line of propagating more hardy strains of Satsuma oranges and the testing out of other fruits was continued during the past year. During a freeze on January 2, in which the temperature dropped to 16 degrees, all round oranges, grapefruit, and lemons were killed almost to the

ground. Satsuma oranges withstood the freeze much better, only the tender ends of the small branches being injured. Most of the trees that were killed back came out in the spring and made a good growth through the summer. All Meyer lemon trees are almost as large as they were before the freeze, and Satsuma orange trees have made excellent growth.

Substation No. 2, Troup

Substation No. 2, Troup, is located one mile northeast of Troup, Smith County, latitude 32 degrees north and longitude 95 degrees west; with an elevation of 483.7 feet above sea-level. The average annual rainfall over a period of 23 years is 42.63 inches. The Station comprises 152.6 acres of land and is located in the central part of the region known as the East Texas Timber Belt. Practically all of the soil of the Station devoted to experiments belongs to the various phases of the Kirvin series, originally correlated as Susquehanna.

This Station, located in an important fruit and vegetable district of East Texas, was established for the purpose of solving the important problems concerned with fruit, truck, vegetable, and general-crop farming in this area. The experiments conducted have included the testing and improvement of promising nuts, fruits, vegetables, berries, and grapes, as well as the more important farm crops. The use of commercial fertilizers and their effect on the crop has received considerable attention.

Tomatoes: The test with tomatoes this year consisted of a comparison of the Gulf States Market and the Marglobe varieties and their response to various fertilizer treatments. The Gulf States Market variety made the largest total yield and did not have as many culls as did the Marglobe variety. The Marglobe tomato seems wilt-resistant, but not immune, and even though this characteristic is desirable in this section, the large percentage of culls and its lower yield to the acre make it a less desirable variety than the Gulf States Market.

The fertilizer treatment of 300 pounds of superphosphate, 150 pounds of nitrate of soda, and 70 pounds of muriate of potash, and the treatment of 300 pounds of superphosphate, 150 pounds of nitrate of soda, and 90 pounds of muriate of potash made practically the same yield. Increasing the amount of muriate of potash from nothing to 70 pounds to the acre made consistent increases in yield. This is contrary to results obtained in former years.

Cotton Varieties: In the cotton variety test, using 17 varieties, the Half and Half variety made the highest yield of lint to the acre, 475 pounds. Kasch ranked second, with 465 pounds of lint cotton; New Boykin third, with 457 pounds; Bennett's Lone Star fourth, with 435 pounds; and Mebane 804 fifth, with 413 pounds. Half and Half and Cook 588 were the only varieties which produced staple less than one inch in length.

Corn Varieties and Date of Planting Corn: Early planted corn this year averaged 22.2 bushels to the acre; medium-planted 21.8 bushels; and late-planted 22.0 bushels. These yields are practically identical and show no advantage for any one date of planting. Over a period of ten years the early planted corn has averaged slightly more in production than corn planted at either of the other two dates, but not enough to be considered significant.

This year the Chisholm variety of corn produced the highest yield, which was only two bushels more to the acre than Ferguson's Yellow Dent, which ranked fifth. The five highest-yielding varieties, in the order named, were as follows: Chisholm, Oklahoma White Wonder, Hastings Prolific, Surcropper, and Ferguson's Yellow Dent.

Sulphur as Fertilizer: Sulphur was applied to cowpeas at the rates of 250 and 500 pounds to the acre. The results indicate that the use of sulphur as a fertilizer is not profitable in this section. In a three-year average, 1925, 1926, and 1927, the yields of seed were: no treatment, 7.9 bushels to the acre; 250 pounds of sulphur, 7.9 bushels to the acre; 500 pounds of sulphur, 8.7 bushels to the acre.

Soil Fertility Investigations, the object of which is to determine the fertilizer requirements of the soil for corn and cotton were started in the spring of 1927. The results of one year's work have been obtained, and indicate that phosphorus and nitrogen are both limiting factors, in the order named. Based on the results for 1927, a small amount of potash is also desirable for cotton. The treatment of 400 pounds of a 12-4-2 fertilizer to the acre made the most profitable yield of lint cotton. The highest yield of corn was obtained from the treatment of 400 pounds of a 12-4-4 fertilizer where two-thirds of the nitrogen was supplied as sulphate of ammonia and one-third as cottonseed meal. The increases due to the fertilizer treatments were barely sufficient to pay for the fertilizers used.

Chilean Nitrate Fellowship: Soil fertility investigations in connection with the Fellowship established at the Texas Station by the Educational Bureau, Chilean Nitrate of Soda, were also begun in 1927. Results of these tests show that the heavier applications of fertilizer made the highest yields of lint cotton to the acre, but that the greatest money value was obtained from some of the lighter applications. There was no significant difference in the yield of the plats which received one-half of the nitrogen before planting and one-half after "chopping" as compared to plats receiving the same total amounts of fertilizer where all of the nitrogen was applied before planting. It is significant that the unfertilized plats produced smaller bolls and a lower percentage of five-lock bolls than any of the fertilized plats. There was no consistent relationship between the size of the boll, the percentage of five-lock bolls, and the amount of nitrogen or fertilizer treatments of any kind. The various treatments did not influence appreciably the percentage, length, grade, or uniformity of lint.

Substation No. 3, Angleton

Substation No. 3, Angleton, is located 3.1 miles northeast of Angleton, Brazoria County, adjacent to the St. L. B. & M. Railway; latitude 29 degrees north and longitude 94 degrees west; with an elevation of 23 feet above sea-level. The average annual rainfall over a period of 14 years is 46.10 inches. The Station comprises 159.3 acres of land, of which 74 acres are in cultivation. This Station is in a region known as the Gulf Coast Prairie and is composed principally of the Lake Charles and Edna series of soils.

The purpose of this Station is to aid in the development of the agriculture on the flat coastal soils. The land is generally flat, but is fertile and productive when proper drainage is provided. The main objectives of this Station are: (1) To determine the best varieties of cotton and corn, fertilizers and rotations for these crops, as well as to conduct breeding experiments for the production of better varieties adapted to this locality. (2) To find the most suitable grasses and clovers and the proper method of growing these for pastures and hay crops in the Gulf Coastal section. (3) To find the best varieties, fertilizers, spraying schedules for the control of rust, pruning methods and cultural practices for the commercial production of figs in the Gulf Coastal section. (4) To make a collection of all of the best adapted ornamentals for this section, including native as well as new species.

Cotton: The Mebane strains of cotton are well adapted to this section of the State. Mebane 804, a strain grown at this Station, made an average yield of 330 pounds of lint cotton to the acre for the past three years, and Kasch has made an average yield of 297 pounds of lint cotton to the acre for the past eleven years. Delfos 6102, New Boykin, Cliett's Superior, and Truitt have also done well during the past three years. Delfos is a long staple, early cotton with small bolls that are hard to pick. In 1927, Kasch, New Boykin, and Delfos 6102 made the highest yields of lint cotton, with an average yield of 475, 456, and 451 pounds to the acre, respectively.

Seventy-five plant selections from Mebane 804 were made in 1927, and were grown in plant rows in 1928. Some promising selections were made from these plant-rows for growing in 1929. One plant of each of the 75 plant-rows was selfed for purification of that strain.

Cotton grown continuously on the same land since 1914 yielded as well as rotated cotton. It may be mentioned, however, that wilt is becoming more prevalent in continuous cotton than it is in cotton grown in rotation.

Corn: Results secured in a variety date test of corn covering a period of ten years show Surcropper, Brazos White, Tuxpan, and Hastings Prolific to be the best yielders. Tuxpan and Hastings Prolific have a better shuck protection and are damaged less by the corn weevil than the other two varieties named. Early planting has given the highest yields, the yields decreasing as the time of planting was delayed. Later planting

caused earlier maturity as measured by the number of days from date of planting to date of first silking.

One hundred strains each of Surcropper and Tuxpan corn are being selfed at this Station to later determine the best inbred strains for hybridization. Two pecularities were noted in the inbred strains this year: One inbred strain of Tuxpan produced stalks of which 50 per cent were of a prostrate or creeping form. One strain of inbred Surcropper corn produced a forked stalk which had an ear and a tassle on each form. The Surcropper strains produced more abnormalities due to the inbreeding than did the Tuxpan strains.

Corn grown continuously on the same land since 1913 has produced an average yield of 13 bushels for the past seven years, as compared to 22 and 23 bushels for corn in four-year rotations.

Fertilizers: The soils of this Station seem to be chiefly in need of phosphorus. Superphosphate gave substantial increase in yield of both cotton and corn, the average increase for the past three years being 60 pounds of lint cotton to the acre and eight bushels of corn to the acre, where 200 pounds of Superphosphate to the acre was used. Increasing the amount of Superphosphate was not profitable unless nitrogen and potash were added. Where 200 pounds of ammonium sulphate was added to 100 pounds of Superphosphate the yield of lint cotton was increased 120 pounds to the acre and the corn 14 bushels to the acre over the plats not fertilized. Adding muriate of potash at the rate of 80 pounds to the acre to the 400 pounds of Superphosphate and 200 pounds of ammonium sulphate gave an additional increase of 30 pounds of lint cotton, but was apparently of no value to the corn. Potash and nitrogen were of little value alone or with the 200-pound application of Superphosphate.

Cowpeas: Results secured from twelve years' work with cowpeas at this Station shows that cowpeas are not suitable for a forage or seed crop. The hay is too difficult to cure and the seed yields are a failure. Cowpeas at this Station are of value chiefly as a soil improver, preferably planted in corn.

Peanuts: In 1927, Carolina Runner peanuts made the highest yield of nuts, 53 bushels to the acre, followed by Virginia Bunch, with a yield of 37 bushels to the acre, and Spanish, with a yield of 29 bushels. For the past 13 years, Virginia Bunch averaged 62 bushels of nuts to the acre; Spanish 51 bushels, and Valencia 43 bushels to the acre.

Forage Crops: In cooperation with the United States Department of Agriculture, this Station is testing a number of new grasses which may have value for growing in this section. The Andropogons are the most promising grasses tested. The Pennisetums offer little promise of being of economic importance in this section, and the Paspalums are little better, although one or two species appear promising. Angleton grass, *Andropogon annulatus,* is the best grass for growing in this section for pasture and hay. It stands up well under pasturing and the stock seem

to prefer it to the native grasses. A large number of distributions of this grass have been made, and where the moisture is abundant and the soils are heavy it is doing well. Attempts to plant a larger area for pasture on this Station were unsuccessful this year, due to the prolonged drouth which set in soon after the grass was planted.

Figs: Magnolia, Brunswick, Lemon, Yellow Neches, and Celestial varieties of figs have done well at this Station and can be recommended for home orchards. The Magnolia is a good variety for preserving, and the Brunswick is a large fig that is excellent as a fresh fig.

In 1927, a 15-day spraying schedule, using Bordeaux 5-5-50, beginning June 1, to October 15, gave the best control of fig rust. The 30-day spraying schedule has given the best control in previous years. The trees on which the rust was not controlled in 1927, winter-killed during the following winter when the temperature reached 16 degrees, while trees properly sprayed were uninjured. The injury was probably due to the fact that the sprayed trees did not go into an early dormant stage, on account of the continued shedding of the leaves from rust injury.

Due to the dry year in 1927, the fig fertilizer results are rather erratic. Superphosphate alone or in combination with nitrate of soda or nitrate of potash gave the highest yields. Lime alone gave an increased yield, but where used with a complete fertilizer it was apparently of little value.

Severe pruning of fig trees produced a late and small crop. No pruning produced an early crop of large figs, but the picking season was very short. Trees pruned half-way back on the last year's growth produced an earlier and larger crop and extended the picking season over a longer period of time than trees pruned according to the common method, that is, leaving only from 6 to 8 inches of the last year's growth.

Other Fruits: Six varieties of pecans are being tested at this Station. The trees grew well this year, but have not produced fruit. These trees were set out in 1918. Several varieties of peaches, plums, persimmons, and citrus fruit were set out in 1928. Several strains of apples and pears are being tested for their blight resistance. The Meyer lemon and Satsuma orange trees were frozen back this year, but are beginning to grow again.

Ornamentals: A number of species of ornamentals have been planted, and new species are being received from the Office of Foreign Seed and Plant Introductions, United States Department of Agriculture. A number of native species have also been obtained.

Substation No. 4, Beaumont

Substation No. 4 is located six miles west of Beaumont, on the S. P. and B. S. L. & W. Railroads and the State Highway to Houston; latitude 30 degrees north and longitude 94 degrees west; elevation 26 to 30

feet above sea-level. The average annual rainfall over a period of 35 years is 48.97 inches. The Station comprises 100 acres of land, consisting mainly of Crowley and Lake Charles clays. These soils are poorly drained and very heavy. The heavy rainfall, long growing season, high seasonal temperatures, with high humidity, level condition of the land, and the large area of heavy clay soil with an impervious subsoil are favorable to the growing of rice in this section. The Station was located primarily for the purpose of developing the possibilities of this industry in connection with other crops which can be used in this section.

Rice Varieties: The improvement of varieties of rice is one of the major lines of work on this Station. A large number of varieties and selections have been tested. In comparing the yields of the three general types of rice, long, medium, and short grain, the varieties of the medium-length group gave the largest yields, with the long- and short-grain groups being practically equal in this respect. In general, the long-grain varieties bring the highest prices and the short-grain varieties the lowest prices. This fact makes it advisable to grow the long- and the medium-length grain varieties in this section. The greatest contribution of this Station in the production of better varieties of rice is the Texas Fortuna. This is an exceptionally heavy yielding long-grain variety that stands up well in the field and possesses very uniform grains. Some of this seed has been distributed and is proving very popular in this section. Bulao Luzon is a short-grain variety that was distributed in several small lots and is giving an exceptionally high yield for a short-grain rice. Results of test at this Station have shown that the commonly grown Blue Rose and Early Prolific varieties are the most satisfactory of the medium-length varieties. Some work is being done with the popular long-grain variety, Lady Wright, with the view of improving its yield and uniformity of grain.

Fertilizer Experiments with Rice: Fertilizer work with rice has been carried on since 1915, and very conclusive results have been secured. The results show that the use of 100 pounds of sulphate of ammonia to the acre is the most profitable of the applications used, and that this should be applied at the time of planting, as the increased yield from a later application is not sufficient to warrant the extra labor involved. The use of lime has failed to increase the yields of rice at this Station.

Germination Tests of Rice Seed: Tests were conducted for the purpose of determining the ability of rice seed to germinate under different conditions, and to compare the viability of red rice and the commonly grown varieties in this respect. Results of the test show that there is practically no difference in the viability of red rice and the commercial varieties when planted under favorable conditions. The highest percentage of germination is secured by planting seed in moist soil, and the lowest percentage is secured by covering the seed with soil and then

turning on water and holding it. A stand can be secured by planting the seed in water, but not covering with soil, and removing the water as soon as the seed begin to germinate. Tests of the germination of hulled and broken grains show that these grains are worthless as far as germination is concerned.

Corn: Corn is not a productive crop in this region on poorly drained soils and should be grown only to a limited extent, unless good drainage is provided. The highest-yielding variety is Tuxpan, while Surcropper and Hastings Prolific are also fairly well adapted. Due to excessively wet weather in the early part of the season and frequent damage from corn root worms, it is almost impossible to plant corn early in this region. As a general rule, corn is planted in this section about the first of May, but if weather conditions are favorable and the land is well drained, it may be planted earlier, and early plantings give the best yields when they escape damage by the corn-root worms.

Cotton: Satisfactory yields of cotton, ranging from two-thirds to nearly a bale per acre, were made from practically all of the varieties tested in 1927. The varieties tested ranked as follows in regard to yield of lint to the acre: Sunshine, New Boykin, Mebane T. S. No. 9611, Delfos 6102, Kasch, Lightning Express, Rowden, Lankart, Acala T. S. No. 9624, Lone Star, Harper, Mebane T. S. No. 804, Bennett's Lone Star, Truitt, and Acala T. S. No. 9616. The length of staple of the better yielding varieties ranged from one inch to one and one-eighth inches in length. The results secured indicate that cotton can be grown profitably in this section of the State and should be included in the crops grown.

Figs: The Magnolia fig is the best variety in this region for preserving. Moderate pruning has given best results. The thirty-day spraying schedule with Bordeaux 10-10-100, beginning about the first of June and continuing until the end of October, has given the best control of fig rust. Unsprayed trees apparently do not enter the dormant period as early as sprayed trees and consequently are more subject to frost injury.

Citrus Fruits: The Satsuma orange seems to be the most hardy variety of citrus fruit in this section, and it seems to be a profitable crop. The Meyer lemon is a very promising citrus fruit for this region, but there is danger of winter-killing, as shown by the injury the past winter.

Substation No. 5, Temple

During the past year, Substation No. 5, Temple, was moved from the original site on the Temple-Belton Pike to a location two miles south of Temple and one-half mile west of the Temple-Taylor Pike on a typical Houston clay soil representative of the main Blackland region. Relocation was also desirable to care for the expanded root-rot program assigned to this substation and constituting one of the principal prob-

lems of the region. This Station is located in latitude 31 degrees north and longitude 97 degrees, and has an approximate elevation of 740 feet above sea level. This Station now comprises 88.13 acres, 72.13 acres on the west side of the M. K. & T Railroad and 16 acres on the east side. The 72.13-acre field is subdivided into the standard acre blocks of the Texas Agricultural Experiment Station system, while the 16-acre field is used for improvements, lawns, arboretum, pasture, and experimental work. The soil of the new location is of the Houston series, and as such is admirably suited for research work on the cause and control of cotton root rot. The average rainfall over a period of sixteen years is 36.11 inches.

Cotton Root Rot Studies: Cotton root rot has been successfully eliminated from a very heavily infected piece of soil by sifting the soil. This sifting resulted in the removal of all live roots which are known to be carriers of the fungus. Adjacent undisturbed soil planted to cotton at the same time showed a heavy infestation of root rot. This experiment, while of limited practical value, indicates that infected live roots are an important factor in the carrying over of the disease. The sifting of the soil to a depth of 30 inches, which was done in this case, may have disturbed the normal spore activity if spores are a factor in carrying over the disease. But at any rate, it shows the significance of cultural methods as a means of reducing disease in cultivated lands.

Cotton root rot has been successfully introduced by artificial inoculation into an area of alluvial soil which was previously free from the disease, and since similar areas are common throughout the Blacklands region, it was desired to know whether these areas embrace some physical or chemical condition unfavorable to the development of the fungus and which therefore inhibited its spread there. The readiness with which inoculation was made, and the reappearance of the disease the year after the first inoculation when several new centers were established, indicates that the soil and soil conditions were not unfavorable to the development of the fungus. The question now presents itself as to whether or not the lack of infestation in this and similar areas was due to a lack of opportunity for infection, or whether some physical or chemical change occurs in such lands at irregular intervals, freeing it from such infestations as have previously entered. This area will be observed in succeeding years to determine whether the disease persists or is eliminated, and the outcome may provide a tangible lead to changes or conditions which inhibit the development of the fungus.

The control of root rot by the development of varieties or strains which are resistant to the disease is one of the important phases of the root rot problem. This season, 5,200 varieties and strains of cotton are under test. These plats are planted very thickly on heavily infested soil, and are watered and inoculated with the root-rot fungus in order that all plants not containing some element of resistance may be killed. As a result, a very high percentage of the plants died from root rot, but it is hoped that some of those remaining will contain an

element of resistance that may be utilized in the development of resistant strains. Any varieties or strains showing resistance will be subjected to more intensive inoculation tests for resistance.

The control of root rot by the use of chemicals and soil disinfectants is of great importance, and is a method which offers promise, especially in the control of the disease in shrubs and other ornamentals in the Blacklands. Work of this Station this season indicates the possibility of organic mercury compounds in the control of the disease in shrubbery where the value of the plant justifies considerable expenditure.

An exhaustive study of root rot as affecting fruit and ornamental plants is being conducted, to ascertain which plants may be successfully grown in the Blacklands. In this project the plants are subjected to inoculation and heavy watering, which favors immediate killing of the plant. Using this work as a basis, a susceptibility table of fruits and ornamentals is being prepared, and this will be of great value to the nurserymen and home owners in the blacklands section.

A variety test of legumes is under way, in which plants grown from seed from many parts of the world are being tested. The susceptibility of all legumes to root rot is one of the limiting factors to the establishment of a permanent type of agriculture in the Blacklands section of Texas. Guar is the only legume that can be grown successfully in the root-rot area at this time, and its planting is very limited.

Attention is being given by the Pathologist to a study of the factors which favor infection. Texas Station Bulletin No. 386, entitled "The Influence of Moisture and Temperature on Cotton Root Rot," dealing with this subject, has been submitted for publication. The depth of infection and the survival of the fungus from one season to another is also under investigation. These studies have already shown that root rot of cotton is deep-seated in the soil.

A systematic botanical study of the weeds of Central Texas is of vital importance in connection with the root-rot program, and this subject is receiving the full attention of the Botanist at Substation No. 5. This study has to do very largely with the underground parts of the plants and has already yielded information of great value. It has been proved that the fungus causing root rot attacks a large number of the native plants and weeds and that they act as carriers of the disease from one season to another. Excavations to a depth of ten feet have shown that the roots of susceptible weeds go deeper. Roots bearing the root rot fungus to a depth of 57 inches have been found. Very often the infected weeds put out new growth and continue to live, even though a large part of their root system is infected. The roots of such weeds constitute a very potent factor in the root rot problem, as it is necessary to eliminate them before the soil can produce a disease-free crop.

The soil regions of the State that are affected with root rot are receiving attention through cooperative tests, in charge of the Substation Agronomist. These tests are mainly cultural and during the month of June excavations showed that in 77.6 per cent of the cases suscept-

ible root rot carriers were present and that cotton itself could have carried the disease in over 44.8 per cent of the cases.

Crop Rotation: A large number of crop rotations are under study on this Station, each with a clean culture period of at least sixty days. Clean culture is accomplished by plowing and listing to a depth of not less than seven inches. Deep tillage operations to a depth of fourteen inches are also under study.

Variety Tests: Variety tests of cotton, corn, oats, wheat, and sorghum are being conducted. These tests are exhaustive and include most of the leading varieties grown in the Blacklands. The cotton variety test includes a statistical study, reports of which have appeared in the Journal of the American Society of Agronomy.

Breeding Work: Breeding work with cotton and corn is under way. Forty-three progeny rows and seven increase strains of Lone Star cotton are in the test this season. The corn breeding work is a part of a general project of the Texas Station, in which the selections are made in self-pollinated lines. The variety used in this work is Mosshart Yellow Dent, T. S. No. 7702.

Substation No. 6, Denton

Substation No. 6, Denton, is located five and one-half miles northwest of Denton, Denton County, on the Denton-Krum Highway; latitude 33 degrees north and longitude 97 degrees west, and at an elevation of 650 feet above sea-level. The Station is located in the Fort Worth prairie region, which is for the most part dark prairie soils, chiefly the San Saba and the Denton series. The average annual rainfall over a period of 16 years is 33.51 inches. The Station comprises an area of 209.92 acres.

The primary objects of this Station are the improvement of small grains adapted to the wheat- and oat-growing region of North Texas, the introduction of new varieties or strains of small grains, and the development and improvement of other crops for this region. Field crops, such as cotton, corn, and grain sorghums are included in experiments at this Station. Plant introduction tests, with particular emphasis on legumes for use in crop rotation in connection with small-grain farming, are an important part of the work of this Station.

Wheat Breeding: Over 300 varieties and selections of winter wheat were tested in replicated nursery rows and field plats. Detailed notes on various plant characters, including rust resistance, winter-hardiness, and yield were taken. In the field plat tests, where eleven varieties and selections of wheat were replicated four times, each under exceptionally uniform conditions, Denton wheat again outyielded all other wheats, with a yield of 34.116 bushels to the acre. In the nursery row tests Denton wheat again showed up considerably better than the other wheats. Its resistance to leaf and stem rusts, and strength of stem above the average is advantageous and seems responsible for the excellent showing made. In

the milling and baking tests of 60 varieties and selections of winter wheat, including 22 samples of Denton wheat from the fertilizer test plats, Denton wheat again made an excellent showing. The 1927 field increase of Denton wheat amounted to 100 bushels, which amount was distributed to 18 farmers in North Texas. Without exception, the 18 farmers made from 3 to 10 bushels more wheat from Denton wheat than from their other wheat.

Another selection of Mediterranean wheat, T. S. No. 3015-72, is a true Mediterranean type in having a purple straw and is a strain of considerable promise. Seventy bushels of this seed were distributed to eight farmers for planting in the fall of 1927. As far as is known, these farmers are well pleased with their 1928 crop.

Crosses of Denton wheat with Kanred wheat were made to obtain, if possible, a segregate that would retain all the desirable characters of Denton and have the stem rust resistance of Kanred. Denton wheat was also crossed with T. S. No. 3015-63, Mediterranean selection, to obtain greater resistance to leaf rust. The first hybrids of these wheats were successfully grown in the greenhouse at College Station.

Other work with winter wheats included the planting of 200 varieties for leaf-rust study and 22 varieties for stem-rust study. This work is done in cooperation with the United States Department of Agriculture. It has been determined that there are three forms of leaf rust and five forms of stem rust prevalent in this State, and that epidemics of rust sometimes originate in southern Texas and in Mexico, where the disease over-winters and is spread northward by wind-borne spores.

Oat Improvement: In the fire which destroyed the Station's office and seed laboratory on December 26, 1927, practically all of a large number of oat varieties and selections were destroyed. This calamity, together with the killing of all fall-planted oat varieties and selections in the severe freeze on January 1, 1928, badly crippled the oat investigational work under way. Enough seed, however, of Nortex, Ferguson T. S. No. 922, Red Rustproof T. S. No. 1118-69, and Frazier oats were saved to plant a spring variety test. These oats were replicated nine times each on 1/14-acre plats. Nortex made the highest yield, 92.70 bushels to the acre. Similar results with Nortex oats are reported from all farmers who grew this variety this year.

Over 1,000 new selections of Red Rustproof oats were planted in head-rows for the first time this year. Only 300 of the best were harvested and threshed for further planting.

Fertilizer Tests: In fertilizer tests, using various rates and combinations of commercial fertilizers on wheat, corn, and cotton, practically no profitable increases in yields have been obtained. Acid phosphate, however, has consistently increased the yields of all crops, but the increase has not been sufficient to pay the cost of the fertilizer.

Rotation Experiments: In rotation experiments, comparing a four-year rotation of wheat, corn, spring oats, and clover with continuous cropping of these crops, wheat in the rotation has again shown the most marked increase, the yield of grain being more than double the yield of continuous wheat. Corn is limited to a greater extent than wheat by weather conditions, but is nevertheless showing a marked increase in yield in the clover rotation. The fact that clover has to be sown in the oats has lowered the yield of the oats somewhat, yet the yields of oats in this rotation are greater than the yield of continuous oats. The second-year clover in this rotation made a yield of two and one-half tons of cured hay to the acre and also a fair crop of seed. Cotton root rot is becoming so prevalent on the plat that grows cotton every year that the yield is very poor. In the rotations there is very little cotton root rot and the average yield this year promises to be satisfactory.

Cotton Varieties: Twenty-one varieties of cotton were grown on the Station during the past season, in 1/22-acre plats, replicated three times. Yields of seed cotton indicate that Sunshine, New Boykin, Wacona, and Ferguson 406 are the high-producing varieties.

Corn and Grain Sorghums: A test to determine the comparative adaptability and productiveness of corn and grain sorghums was planted, using eight varieties of grain sorghum in comparison with Surcropper corn. Chiltex, Darso, Hegari, and Blackhul kafir were the high-producing varieties, while Milo and Feterita were the only grain sorghums which yielded less than Surcropper corn.

Clovers: Twenty-eight selections and hybrids of biennial white clover and biennial yellow sweet clover were planted in the spring of 1927. The growth and character of these plantings this year show that several of them are promising for this section of the State.

Winter Peas and Vetch: Varieties of winter peas and vetches were planted again this year. Austrian winter peas and Hairy vetch were the only varieties to survive the January freeze. About fifty per cent of the plants survived. Subsequent growth, however, was not good and no hay or seed were harvested. A spring planting of Austrian peas made a fairly good growth and yielded three-fourths of a ton of dry hay.

Substation No. 7, Spur

Substation No. 7, Spur, is located one mile west of Spur, Dickens County, latitude 33 degrees north, longitude 100 degrees west, and at an elevation of 2274 feet above sea-level. The average annual rainfall over a period of 17 years is 21.68 inches. The soil of the Station consists of the Abilene clay loam and the Miles clay loam.

Spur is on the low rolling plains just below the escarpment known as the Cap Rock. Much of the land in this section of the State is rough and suitable only for grazing purposes. The rolling prairie land

and the alluvial bottom lands along the water courses are among the most productive soils in the State. Cotton is the principal crop of the region, with 70 to 80 per cent of the cultivated land being planted to this crop. There is an increasing interest in the fattening of cattle, sheep, and hogs for the market, and during more recent years the farmers have been adding more and better breeds of dairy cattle to their farm herds.

The Station is concerned with three principal lines of work: the further development of profitable crop farming under conditions in this region; the utilization of crops grown in the region in the fattening of cattle and sheep; and a study of run-off water and soil erosion in relation to crop production.

The development of crops and the study of crop-farming practices and the dissemination of the information obtained to a large population of new farmers, in a new agricultural region, has been helpful in making this region the dependable farming section into which it has developed.

As late as 1915, the grain sorghum crops of the region had little or no value on the primary grain markets and were not even held in high esteem by the farmers who produced them. The railroads had considerable trouble in hauling the grain sorghums, both as threshed grain and in the head, as the damage in transit was heavy, even on short hauls, due to loading before the crop was thoroughly mature. Experiments have shown that grain sorghum is practically equal to corn pound for pound, and cattle and lamb feeding in the section is increasing rapidly. No experimental feeding was done during this season owing to feed conditions, but it is planned to feed out experimental lots of both cattle and lambs this winter in the further study of feed utilization.

Cotton Varieties: Half and Half has yielded more seed cotton than other varieties, and with the lack of premium for quality of staple paid by buyers, the region is rapidly becoming a heavy producer of this variety of cotton. The early maturing strains of Mebane are well adapted to the region, as they have a combination of most of the desirable characters and a staple most desired by the largest number of spinners.

Increasing Selected Strains of Cotton: Eight of the ten promising selections of cotton which were developed from Mebane, T. S. No. 804, have been discarded and the remaining two have been increased to where there are available 100 bushels of seed of each strain. Selection No. 14 is one of the most promising cottons that has been tested at this Station. It is a vigorous grower, has large storm-resistant bolls and staple of exceptional quality ranging from 1⅛ to 1 3/16 inches. Selection No. 53 will probably be more popular with the farmer than No. 14, because it has a low, compact fruiting habit, is early maturing, and a heavy producer. The staple is 15/16 to one inch in length.

Fifteen-inch Spacing Best: Cotton spaced 15 inches apart in the row produced the highest yield this year. Over a period of years there has

been little difference in spacing cotton 6, 9, 12, 15, and 18 inches in the row. The cotton plant has the ability to adapt its growth and fruiting to the space allotted between 6 and 18 inches in the row. Thicker spacing has been unprofitable.

Date of Planting Cotton: April and early May plantings of cotton failed to germinate, due to a shortage of soil moisture at planting time. Cotton planted May 16 was the first to germinate. Over a period of years, cotton planted from May 1 to 20 has been the most profitable.

Yolo and Chiltex High Yielders: Twelve varieties of grain sorghums were tested this year. Yolo, a chance field hybrid between kafir and feterita, from California, was the highest, and Chiltex, a hybrid from crosses made between feterita and kafir at the Chillicothe Station, was second in yield of grain. Red kafir, which is credited with the high yield last year, together with Hegari, Standard Blackhul kafir, and Pink kafir, failed to mature grain. Over a period of years, milo is the most dependable grain producer of the grain sorghums. Over a long period of years, milo has made an average yield of 30 bushels of grain to the acre, and Hegari has made 19 bushels. Hegari is rapidly gaining favor with the farmers, but it has been so erratic in production that it cannot be classed as one of the profitable grain sorghums to grow.

Twenty-four-inch Spacing of Milo Gives High Yield: This year, milo plants spaced 24 inches apart in 36-inch rows, made the highest yields. Over a period of years, 18 to 24-inch spacing has proved to be the optimum spacing for the production of grain.

Time of Planting Milo: Milo planted in June made larger yields than plantings made in May or July. Plantings during the first few days in July made a larger crop than plantings in May. Over a period of years, seven plantings made in April have averaged 32 bushels of grain to the acre, 20 plantings made in May have averaged 28 bushels, 20 plantings made in June 26 bushels, and 7 plantings made in July have averaged 24 bushels to the acre.

Studies of Soil and Water Losses: The project on run-off water losses and soil erosion in relation to crop production has produced a wealth of basic information as to the water losses affecting crop yields annually, and also to soil losses through sheet erosion, a skinning-off process of the rich surface soil and organic matter, which is rapidly causing waning productivity.

Of the total rainfall of 16.79 inches during the crop growing season of 1928, 4.39 inches was ineffective light showers, and on average land with two per cent slope an additional 3.7 inches of the rainfall was lost as run-off, leaving a possible balance of 8.70 inches that could be used for plant growth and fruiting. There is no possible way of correcting the small ineffective showers and the whole water-soil conservation program necessarily hinges on controlling the storm waters during heavy

rain peaks. It is evident that West Texas is operating on an annual effective rainfall of 8 to 12 inches, and that this effective rainfall can be increased from 20 to 40 per cent by means of properly constructed terraces.

There is a dire lack of information as to what slope and character of lands are most resistant to water losses and soil erosion. The movement of water across land seems so free and the friction so negligible that heavy water and soil losses may occur on land which appears to be practically level. Of a total of 60.90 inches of rainfall, 10.28 inches was lost as run-off on land having a one per cent grade and planted to cotton, and 11.40 inches on two per cent grade planted to cotton. It seems, therefore, a good farming practice to terrace lands that are practically level.

Some very definite results have been secured as to the increased water and soil losses occurring on cultivated lands as compared to lands heavily sodded with native grasses. During the past two years there has been .11 of an acre inch of water lost from a grassed plat with a two per cent grade and 4.27 inches from land having the same slope planted to cotton. Over the same period and with the same slope of land there has been 1.04-acre inches lost from a plat planted continuously to milo.

For the past three years there has been an average annual loss of 9.3 tons of soil per acre, as sheet erosion, from land with a one per cent slope planted to cotton, and 12.61 tons of soil per acre from land with a two per cent slope. With every acre inch of water lost approximately three tons of soil eroded. During the past two years .08 tons of soil was lost from a grassed plat with a two per cent grade, 10.14 tons from the same slope of land planted to cotton, and 26.65 tons from the same slope of land that has been fallowed. From these data it is very evident that a crop covering and a vegetative litter is needed on the land to hold the soil in place and prevent its soluble components from being washed away. The depletion of soil fertility caused by erosion is apparently much greater than that caused by the removal of plant food from the soil by crops. A large portion of the losses caused by erosion occur at the time of torrential spring rains or at a time of the year when there is no crop covering to retard the water and soil movement.

Two field areas were terraced with a fall of two feet between the terraces. On one of the plats the terraces were built with the contour of the land (on the level), and on the other a fall of three inches in 100 feet along the terrace was given, or a fall of one-fourth of one per cent. During the past spring, during a period of heavy rainfall, 12 per cent of the water that fell on the level plat was lost as run-off, and 32 per cent was lost from the plat that had a fall of one-fourth of one per cent in the terrace. During 1927, .69 per cent of the rainfall was lost from the level plat and 3.47 per cent from the plat with a fall in the terrace of one-fourth of one per cent. From data collected over a three-year period, it is very evident that level terraces are better for saving storm

waters and are more practical in construction and maintenance than terraces with a fall.

On two field areas, one planted to cotton and the other planted to alfalfa, all of the water that fell on the areas has been conserved, and materially increased yields have been secured.

With a better understanding of the nature and character of the rainfall and with the development of practical methods of holding the water on the land where it falls, a more permanently stabilized agriculture and a reduction of the risk element in crop farming may be expected to follow in regions of limited rainfall.

Substation No. 8, Lubbock

Substation No. 8, Lubbock, is located three miles east of Lubbock, in the High Plains region of Texas and near the center of what is known as the South Plains; latitude 33 degrees and 36 minutes north, and longitude 101 degrees and 45 minutes west; at an elevation of 3106 feet above sea-level. The average annual rainfall over a period of 17 years is 19.56 inches, with yearly extremes of 8.73 and 31.88 inches. The Station comprises 160 acres of land, 142 acres in cultivation and the remainder in pasture, farmstead, and so forth. The soil of the Station is of the Amarillo and Richfield fine sandy loam type, which is typical of a great portion of the section.

The Station has played an important role in pointing the way toward the better use of agricultural land in this section and has been instrumental in converting the region from a strictly ranching section to one of wide possibilities in crop production. The work of the Station has been directed chiefly toward determining the most successful practices in the preparation of the soil, and in the planting and cultivation of crops grown; the introduction, breeding, and improvement of the grain and forage sorghums, which have been found to be the basic agricultural crops of the region; the breeding and improvement of varieties of cotton adapted to high altitude and limited moisture conditions; the determination of the best method of soil management and crop treatment; and the collection of reliable information on fruit and truck crops, shade and ornamental trees and shrubs, legumes and other crops adapted to the region. An important feature of the work of the Station is the determination of the value and efficiency of windmill irrigation as applied to individual farms and its practicability in connection with irrigating small orchards, gardens, and other specialized crops, such as small areas of alfalfa for hogs and poultry.

Grain Sorghum Varieties: Twenty-seven varieties and strains of grain sorghums were grown this year. Premo, Dwarf Yellow milo and Darso, yielding at the rate of 41.07, 37.44, and 37.13 bushels per acre, respectively, made the greatest returns. Conditions were favorable for sorghum production during the past year, so that yields were some twenty per cent

above the average as a whole. Over a period of years, kafir and feterita are included in the list of high-yielding varieties.

Date of Planting Grain Sorghums: Planting on June 20 returned yields 17 per cent greater than did planting on April 20. The optimum planting date over a period of years is May 20, but this year the ground was too dry to plant until the middle of June.

Tillering of Milo: Tillering can be suppressed or induced by proper and timely cultivations. Poor stands are often obtained, and it is difficult to decide whether or not to replant. By the use of the lister cultivator (godevil) until late in the season ten per cent more tillering was induced than in plats where the cultivator was used and dirt thrown to the plants.

Row Spacing of Milo: The practice of not planting every third row of milo has been advocated from time to time, with the idea that in dry years a good crop yield would be certain. The results this year show that the usual method of planting made a gain of ten per cent in yield over the method where every third row is left unplanted.

Treatment of Grain Sorghum Seed with Chemical Compounds: Four different grain sorghums were treated with Bayer Dust, Uspulun, and copper carbonate and planted at intervals of ten days, beginning with April 25. No significant difference in germination could be noted between the treated and untreated plats from averaged counts.

Cotton Varieties: Due to the dry spring, cotton could not be planted before the middle of June. Consequently, the early-maturing, small-boll and medium-staple-length varieties made a much better showing than the larger-boll, late-maturing strains. Westex and Mebane, T. S. No. 804, were, as usual, among the four highest-yielding strains. Forty-six per cent of the total crop was harvested as "bollies." Sixty-four per cent of the crop of Sunshine and seventy-four per cent of the crop of Lone Star were harvested as bollies, while thirty-two per cent of the crop of Mebane, T. S. No. 804, and Westex was harvested as bollies.

Experiment with Commercial Fertilizers for Cotton: With a view of determining the effect of commercial fertilizer upon cotton yields, superphosphate and ammonia, used singly and in combination at different rates to the acre, have been applied the past four years. Results to date show no beneficial effect from the application of commercial fertilizers to cotton. On the contrary, slightly decreased yields have been obtained.

Sweet Sorghum Varieties: Sumac, Kansas Orange, and White African made the highest tonnage of forage this year. Over a period of years, an average of between three and four tons of dry forage to the acre may be expected from these varieties.

Substation No. 9, Balmorhea

Substation No. 9, Balmorhea, is located four miles east of Balmorhea, on the Old Spanish Trail Highway and on the Pecos Valley & Southern Railroad; latitude 31 degrees north and longitude 103 degrees west; approximately 3,000 feet above sea-level. The average annual rainfall over a period of five years is 14.05 inches. The average rainfall is too light to permit of crop production without irrigation. The Station property consists of 200 acres, 80 acres of which is under irrigation and the rest in pasture.

The Station is located at the foot of the Davis Mountains in the central part of the Madera Valley, formerly known as the Toyah Valley. Irrigation water is available from springs and also from run-off water from the mountains. The work at this Station is directed toward the solution of the problems which confront the irrigation farmer in the Southwest. The solution of these problems in farming practices, insect and plant disease control and the substitution of new and better varieties of horticultural and field crops would make farming in this section more profitable and build up a more stable system of agriculture. The experimental work conducted at this Station may be divided into two general classes: Horticulture and agronomy.

Up to the present time the horticultural work has consisted largely of the testing of various kinds and varieties of fruits, in an attempt to discover those best suited to the region which the Station serves, and also to find, if possible, varieties of horticultural and ornamental crops which are resistant to cotton root rot, which is prevalent in many of the irrigated valleys of the Southwest. This disease is very destructive to a wide range of horticultural crops. Many varieties of fruits, nuts, grapes, berries, and ornamentals are now being tried out on this Station. While many of these have not been grown over a long enough period to justify the drawing of definite conclusions, observations indicate that the hardy varieties of *Vinifera* grapes might be successfully grown on a commercial scale, and that late-blooming varieties of plums and blight-resistant pears might be grown for local consumption.

Ornamentals: The work with ornamentals has been directed largely toward the problem of selecting those which will withstand the existing climatic conditions and also show some resistance to the root-rot disease. The flowering pomegranate, live oak, pecan, honeysuckle, and tamarix thrive fairly well and seem to be more or less resistant to the diease, although they may not be entirely immune. The hackberry shows some resistance, but is not so well adapted to climatic conditions in this region.

The Agronomic Work has dealt largely with the introduction of new varieties and crops, determining the value of fertilizer treatments and methods of building up the soils. Virgin soils in this section are very low in organic matter, and the addition of phosphoric acid and nitrogen without the addition of humus has had little effect on the crop yields. After alfalfa has been grown for a few years and is then plowed up, yields

of succeeding crops are greatly increased, and it is possible that additions of phosphoric acid to such soils might give better results. The application of sulphur and potash had no apparent effect upon the yields of crops to which they were applied.

Alfalfa Crops: Since a considerable acreage of alfalfa is planted in the irrigated valleys of the Southwest, some attention has been given to the development of varieties especially adapted to this section. Forty strains were planted in the fall of 1924. From this lot, two have been selected as being superior for planting in this section of the State. Work with these varieties has definitely shown that the Hairy Peruvian variety should not be planted on ground which is subject to the cotton root rot. Under favorable conditions, this variety will make high yields, but if root rot is present the stand is killed out much quicker than in the common varieties.

Cotton: Cotton variety tests covering a period of several years have indicated that the Acala variety is one of the best varieties for growing in the irrigated valleys of the Southwest, and the other varieties have been largely replaced by the Acala variety.

Grain Sorghums produce well, but these crops are badly damaged by birds because of the limited acreage grown.

Corn: Climatic conditions are usually very unfavorable for the production of corn, and it is believed that this crop can never be grown commercially in this section.

The work of the Station is being directed toward the establishment of a more stable and profitable system of agriculture in the Western irrigated districts. This may be brought about by building up the soils, improving cultural methods, and the introduction of new and improved crops.

Substation No. 10, Feeding and Breeding Station

Substation No. 10 is located one mile northwest of College Station, Brazos County, on the public highway; latitude 30 degrees north and longitude 90 degrees west; 308 feet above sea-level. The annual average rainfall over a period of 37 years was 37.93 inches. The lands owned and assigned to the Feeding and Breeding Station comprise 901.8 acres.

The major purpose of this substation is to provide a centralized laboratory near the Main Station and the Agricultural and Mechanical College for studies in feeding, breeding, and management of swine, dairy cattle, and poultry. Progress of the work on projects with poultry, swine, and dairy cattle which is being conducted at the Feeding and Breeding Station is reported on elsewhere in this report under the respective divisions concerned.

Of the land embraced in this station, 240 acres are in cultivated crops and 630 acres in native pasture. The cultivated land is used

for the production of silage, forage, and cultivated pasture. The land not in cultivation is receiving attention with a view of cleaning out the weeds and brush, thus improving the native pasture and establishing permanent Bermuda grass pastures in certain areas.

Substation No. 11, Nacogdoches

Substation No. 11, Nacogdoches, is located two and three-fourths miles north of Nacogdoches, Nacogdoches County, on the Nacogdoches-Timpson Highway; latitude 32 degrees north and longitude 94 degrees west; elevation 292 feet above sea-level. The average annual rainfall over a period of 15 years is 48.64 inches. The Station comprises 81.6 acres of land.

The purpose of this Station is to serve the region of Texas in which the Nacogdoches or "Redland" soils occur. The red lands of the Nacogdoches series are among the earliest settled farm lands in the State. This soil is very productive, but since much of it has been in cultivation for a long time, one of the chief problems is that of systematic and orderly cropping practices to build up and maintain soil fertility. Crop rotation, including legumes and green-manure crops to build up soil fertility, the determination of the need of these soils for fertilizers, together with the rate and time of application, and the development of horticultural and agronomic crops suited to a diversified agricultural program for this region, are outstanding problems with which this Station is primarily concerned.

Soil Fertility Work: The objects of this work are to determine the best analysis of fertilizer and the optimum rate of applying the fertilizers to cotton and corn. In conducting soil fertility work in this section, it is kept in mind that terracing of the land is very important for the conservation of fertility and also the conservation of soil, which is otherwise lost through erosion. This work should also include the incorporation of organic matter at every possible opportunity, together with rotation of crops on the land as often as possible and practicable.

In the fertilizer work with cotton during the past year, the analysis of 6-4-4 applied at the rate of 400 pounds to the acre gave an increase of 44 pounds of lint cotton over the unfertilized plats, with a net profit of $4.84 to the acre. Although an application of 12-6-4 at the rate of 400 pounds to the acre gave an increased yield of 54 pounds of lint cotton to the acre, the actual net profit derived was only $4.16, due to the increased cost of this analysis. The 12-4-4 analysis was used at the rates of 200, 400, 600, and 800 pounds to the acre. The yield of cotton increased as the rate of application was increased.

Barnyard manure applied at the rate of twelve tons to the acre gave an increase of 22.6 bushels of shelled corn to the acre over the unfertilized plats. Likewise, an application of 12-8-8, at the rate of 800 pounds to the acre, gave an increase of 22.6 bushels to the acre over the unfertilized plats. The greatest net profit derived from this test, how-

ever, was from the commercial fertilizer in the form of 12-8-4 applied at the rate of 400 pounds to the acre.

Fertilizer Work Under the Chilean Nitrate of Soda Fellowship: Tests were conducted during the past year on cotton, using various formulas and amounts of commercial fertilizers for determining their effect on the yield and other factors of importance in the production. Results show that the yield of lint cotton increased as the amount of nitrate of soda was increased up to 200 pounds to the acre, and beyond this amount the production of lint cotton decreased as the nitrogen increased. Applications of potash were profitabe up to and including sixty pounds to the acre. The effect of side-dressing with nitrate of soda on yield as compared with the same amounts applied before planting showed very little difference. The percentage, length, and grade of lint were not greatly influenced by the various treatments of fertilizers. The various treatments of fertilizers did not show a consistent effect on the earliness of maturity, percentage of four- and five-lock bolls, size of bolls, and shedding. The greatest net profit was obtained from an application of 300 pounds of superphosphate, 300 pounds of nitrate of soda, and 60 pounds of muriate of potash, one-half of the nitrogen being applied as a side-dressing.

Cotton Variety Tests: Tests conducted during the past 16 years show conclusively that varieties, such as Acala, Half and Half, Lightning Express, Lone Star, and Truitt are the highest yielders of lint cotton in this section of the State. Of the eleven varieties planted during the last year, Bennett's Lone Star was high yielder, with 217 pounds of lint cotton to the acre. Lightning Express was second in yield, with 212 pounds of lint cotton to the acre, and Half and Half was third, with 195 pounds of lint cotton to the acre.

Corn: The ear-to-row breeding system as formerly used was replaced by a new breeding project, in which the selections are made in self-pollinated lines. An outstanding local variety, the Nacogdoches, T. S. No. 4216, and the Surcropper variety, are being used in this work. Increase in yields, through uniform production of every plant, elimination of inherited plant diseases and other factors, are the ultimate aims of this project.

In the corn variety test during the past year, fourteen varieties were used. Nacogdoches, T. S. No. 4216, was the high producer, with 42.4 bushels of shelled corn to the acre. Blue Grain, T. S. Number 935, was second in yield, with 37.3 bushels to the acre, and Rockdale, T. S. No. 9735, was third, with a yield of 36.5 bushels to the acre.

Peanut Variety Test: Results secured in the peanut variety test during 1926 and 1927 show that the large-podded varieties are poor producers in bushels to the acre as well as test weights of pounds to the bushel when planted on the uplands of Central East Texas. The smaller-

podded varieties produce satisfactory yields of forage and nuts. Selections which have been made at this Station from the Little Spanish variety have been increased and are now being distributed to growers. One strain of these selections known as Macspan, the yields of which are shown in Texas Station Bulletin No. 381, "Peanuts in Texas," is more vigorous in growth, produces higher yields, and bears a larger and more uniform pod than does the Little Spanish variety.

Cowpeas: In a test of cowpeas for forage production covering a period of eight years, the highest yields were obtained from the Iron X Whippoorwill, Brabham, and Unknown varieties. Results of a test of cowpeas for seed covering a period of fifteen years shows that the Whippoorwill, New Era, and Clay varieties are the highest producers. The Brabham cowpea is valued in this section for its forage- and seed-yielding qualities, as well as for its ability to withstand attacks of Fusarium wilt.

Horticulture: An extensive program of breeding and fertilizing of peaches, blackberries, dewberries, and tomatoes was planned during the year. Necessary preparations for conducting this work were made, including the assembling of laboratory equipment and field supplies. Special attention will be given to the breeding of a peach having an earlier maturing date, higher sugar content, and the shipping qualities of the Elberta. One of the parental plants to be used was introduced by the United States Department of Agriculture, Bureau of Plant Industry, under S. P. I. No. 43,290. Two specimens of this introduction bloomed during the latter part of December, 1927, and early in January, 1928, withstanding temperature of 12 degrees Fahrenheit, and setting a heavy crop of fruit, which matured about June 25, indicating hardiness of bud, an important factor in this work.

Breeding of the blackberry will be for the purpose of selecting a fruit of high sugar content, which bears abundantly, and is a good shipper. Cultural tests will also be conducted, including fertilization, tillage, pruning, and spraying.

A tomato breeding and fertilizer program has been initiated, with the object of determining the maximum net profits to be secured from plantings of the tomato, and to introduce a variety having more desirable characters than those now being planted in this section.

Substation No. 12, Chillicothe

Substation No. 12, Chillicothe, is located four and one-half miles south and one mile west of Chillicothe, Hardeman County; longitude 99 degrees west and latitude 34 degrees north; elevation 1,406 feet above sea-level. The average annual rainfall over a period of 23 years is 25.63 inches. The Station comprises an area of 100 acres of land and serves a region in the northern part of the Redbeds area, in which the Vernon and Kirkland series are the principal soils.

This Station was established as a cooperative forage-crop testing

station, operated jointly by the Office of Forage Crops Investigations, United States Department of Agriculture, and the Texas Agricultural Experiment Station. The work of this Station, however, also includes the testing of cotton, corn, sorghums, small grains, legumes, and other field crops important to the region.

Cotton: The series of years from 1924 through 1927 is the best period of years, from the standpoint of cotton production, this section has ever experienced. The results of the cotton test for the year 1927 are in keeping with the results of previous years, as reported in Texas Station Bulletin No. 366, entitled "Varieties of Cotton in the Red Prairies of Northwest Texas." Varieties of short lint and high lint percentage were the high producers; those of the big boll group which produce lint of 1-1-16 inch were the medium producers; and those of the long staple group were the low producers. The most outstanding results were secured with Western Wonder and Half and Half in the short staple group; with Mebane T. S. No. 4120, New Boykin, and Kasch in the Mebane group; and with Delfos in the long-staple group.

Corn: Since sorghums consistently outyield corn in this section, except in certain favored localities, corn is not a profitable crop to grow. June corn and Surcropper are the best varieties of those tested.

Sorghums: The standard varieties of grain sorghums which have been tested over a period of fifteen years have about the same average yield of grain. The fact that the average yields are about equal for those varieties is largely the result of the great variability of seasonal conditions and the different reaction of the varieties to seasonal conditions. Those varieties which produce most consistently and have the greatest utility are the most valuable. Hegari, kafir and feterita are the best forage varieties. These, along with milo, are also the best grain producers. During recent years, chinch bugs have been increasing in destructiveness and are making milo an uncertain crop. The kafirs and Hegari have been the best producers during recent years, and Kansas strains of the red and the pink varieties of kafir have performed unusually well. Among the sorgos Sumac is the outstanding variety, but a number of newer varieties, among them African Millet and Atlas, have possibilities. Honey sorgo produces more forage, but much less grain, than Sumac and has the disadvantage of being hard to handle at harvest time.

Cowpeas: Of the cowpea varieties tested, Groit is the most valuable. It produces a good crop of vines and is a fair seed producer.

Wheat: Hard winter wheats are the best for this section. Kanred, Turkey, and Clark's Blackhul have given the best results over a period of years. Spring wheat cannot be grown profitably.

Oats: Spring oats are not a profitable crop in this section, but the early strains of Texas Red Rustproof and Fulghum are the best.

Cotton: A continuation of the cotton-spacing test this year substantiated the results of previous years. Cotton should be "chopped," and spacing as wide as thirty inches in the row is not detrimental. In favorable seasons close spacing, 3 to 6 inches in the row, will yield about the same as cotton with a thinner stand, but in years of drouth the thinner stands make a higher yield. The limiting factor in production at the present time is soil moisture, rather than soil fertility. The application of fertilizers to cotton has not influenced the yield. The results of seed-bed preparation and cultural practices with cotton are not conclusive, but indications are that any method which will result in a good seed-bed is suitable. The exact time of preparation is apparently not very important, providing it is done two to three months previous to planting time, since winter rainfall is light and weed growth sparse.

Sorghums: In a test conducted through three years, the proper planting of one pound of seed each of milo, Blackhul kafir, and Sumac sorgo resulted in the following stands: milo, 18 inches; kafir, 11 inches; Sumac, 7 inches. Two pounds of seed resulted in stands of 8 inches for milo, 6 inches for kafir, and 4 inches for Sumac. These stands were secured with good seed under field conditions, on a good seed-bed, on two different dates each year, and show that it is not necessary to plant more than two pounds of seed to the acre of any of these varieties. Milo may be seeded with every third row not planted with no appreciable loss in grain yields. The results are not conclusive, but it is probable that milo may be planted in rows as wide as 80 inches without any reduction in yield. A good farm practice would be to plant so as to get a stand in case conditions for germination turned out to be poor. In case of favorable conditions resulting in a thick stand, every third row could be listed out, thereby leaving the desired stand without resorting to hand thinning.

Seed Treatment: Feterita seed treated with copper carbonate, Uspulin, Bayer Dust, and Semesan have germinated better in the field than untreated seed by 57 per cent, 72 per cent, 75 per cent, and 84 per cent, respectively. Under favorable conditions for germination, these figures would not be nearly so high, as these are the figures for only one year. The treatments aid germination by controlling fungus diseases which rot the seed in the soil during cold, damp weather.

Date Test of Corn and Sorghum: Sorghums produce a better feed crop in this section than corn. Corn produces only 67 per cent as much as the sorghums when each is grown under its optimum condition. Corn should be planted by April 1, and sorghums may be planted any time after April 15. Late plantings of sorghums produce the highest yields,

but late plantings must be harvested at the time when cotton is being picked.

Sorghums: Hybridization and selection as methods of crop improvement were continued, and crosses with combinations of milo, kafir, feterita, Hegari, White African, Sumac, Red Amber, Orange, Honey, and Java parentage were grown. Most of the hybrids are in the early generations following hybridization, but two varieties of grain sorghums and two of sorgo are approaching uniformity and will be distributed as soon as their superiority is established by field trials in different localities. These varieties are selections from the progeny of the following crosses: (feterita x kafir) x kafir; (feterita x kafir) x feterita; White African x Sumac; and White African x Honey. The first is a high forage- and grain-producer, with a stalk almost as sweet and juicy as sorgo. The second is a high grain-producer, which looks much like feterita, but does not shatter badly. The third is a high-yielding, sweet and juicy sorgo that stands up well, and the last is a sorgo which resembles Honey closely, but produces much more seed. Among the hybrids that are still segregating, a cross between milo and Hegari seems to have possibilities. A back cross of milo on a milo x kafir hybrid is being used to breed a milo type plant that is resistant to chinch bug attack.

Cotton: Breeding work with cotton has been in progress since 1925. Ten high-producing, uniform strains of high lint percentage and one-inch staple are now being tested. Distribution will follow as soon as the superiority of one of the strains is estabilshed.

Grass Nursery: Of the grasses tested during the year, the only ones of promise are *Cynodon barberi* and *Cynodon intermedius*. The former is a rank growing Bermuda grass which seems to have possibilities as a permanent pasture grass, and the latter is a fine-stemmed Bermuda grass which will make a better lawn grass than the common Bermuda grass.

Milo Disease: Studies were continued on what is apparently a new disease of sorghums, which is most destructive to milo. Inoculations with organisms isolated from diseased tissue and grown in pure culture appeared to reproduce the disease. The exact nature of the disease has not been determined, but it is apparently a weak parasitic disease that is associated with chinch bug attack.

Substation No. 14, Sonora

Substation No. 14, Sonora, is located 26 miles southeast of Sonora, on the Sonora-Rock Springs road; latitude 30 degrees north and longi-

tude 100 degrees west; elevation approximately 2,400 feet above sea-level. The average annual rainfall over a period of ten years is 24.39 inches. The Station lands consist of 3,461.63 acres, serving a region known as the Edwards Plateau and comprising an area where the Angora goat and sheep industries are important and highly centralized.

The mission of the Station is to study the problems which confront the stockmen and farmers in a section adapted primarily to extensive stockraising, to collect exact and comparative data, and to make recommendations looking toward the development of the agriculture of the region along sound economic lines. Some of the most important lines of work carried at this Station are as follows:

Range Vegetation Studies: The work done this year consisted in studying the range in the Trans-Pecos area of Texas in connection with the reconnoissance soil survey of that area, which is being made at the same time. The vegetation was classified under five general types: (1) grassland, (2) creosote bush-black bush-acacia, (3) lechuguilla-sotol, (4) mesquite-sand sage, and (5) bottom land, mixed trees, and shrubs. These types were represented in varying gradations of character, and a number of subdivisions, especially of the grassland type, have been recognized. A detailed report of this work will be made at an early date.

Carrying Capacity Studies: Data recording the carrying capacity of the pastures of the Experiment Station Ranch, which is stocked with cattle, sheep, and goats, are complete for five years. A detailed report of this work will be made at an early date by the Division of Farm and Ranch Economics. It is believed that the complete analysis of these data will indicate the most desirable number of cattle, sheep, and goats, and the proportion of each, for stocking the range of the Edwards Plateau.

Swellhead of Sheep and Goats: In continuation of the experiments reported in the 1927 Annual Report on swellhead of sheep and goats, dry-lot feeding tests were undertaken in which fallen live oak leaves, shin oak leaves, and Saccahuiste buds, or a combination of these, were used, gave no conclusive results. Contact experiments, in which goats suffering with swellhead were confined in dry lots with healthy sheep and goats for as long a period of one month, gave negative results. Attempts to transmit the disease from animal to animal by injections of various emulsions of the parencymatous organs or whole blood from goats suffering from swellhead into healthy goats were also negative.

External Parasites of Sheep and Goats: Fly trapping records have been completed and are being summarized for publication. Some work has been carried on relative to repellants and killing agents. The most satisfactory repellant seems to be Pine Tar Oil, specific gravity 1.065 plus enough unused lubricating oil to make the mixture hold well.

Sheep Scab: It has been found that the recommended dipping solutions of lime-sulphur and nicotine sulphate are efficient in destroying

the sheep scab mite if properly administered. It was also found that the mites can live off the host only for a short time on the bedding grounds or in the pasture. This project has been closed and the data will be published as soon as possible.

Goat Louse: In continuation of the studies on goat lice (T. climax, T. hermseii, and L. stenopsis) killers when used as a dip, it was found that both lice and eggs are killed at a single dipping when the animal is held in the dip for one-half minute and the head thoroughly immersed several times in the following substances: Electric, Ferric, Static, and Thylox brands of sulphur, using 5, 10, 20, and 5 pounds, respectively, to each 100 gallons of water, plus one-half ounce of fish-oil soap to the gallon. The same results are also obtained when the animals are dipped in standard arsenical dipping fluid testing 0.22 per cent arsenic trioxide. Care, however, must be exercised in using this dipping fluid on account of its poisonous properties for sheep and goats. Cottonseed oil emulsions will also kill both parasites and eggs, but has the disadvantage of permanently staining the mohair.

Sore Mouth of Kids and Lambs: Experiments are being conducted with the view of locating the origin of the infection in cases of new outbreaks, for which purpose the soil from sheep sheds was rubbed into the lips of the unaffected lambs, both before and after scarification. No conclusive results have been obtained at this time, but the experiment is being continued. The most satisfactory treatment found to date consists of a mixture of four parts of pine tar and five parts of unused lubricating oil, to which one or two per cent of cresol has been added.

Numerous other problems are frequently suggested by the ranchmen, the solution of which would greatly benefit the ranching industry. Two of these, Coyotillo poisoning and bitter-weed poisoning, have been studied in a preliminary way, but not sufficient data have yet been collected to justify the drawing of any conclusions. These studies are being continued as time permits, and important results will be published as they become available.

Substation No. 15, Weslaco

Texas Substation No. 15, the Lower Rio Grande Valley Experiment Station, lies adjacent to Llano Grande Switch in Hidalgo County, bordering the concrete highway traversing the Valley and about midway between Weslaco and Mercedes. The farm comprises 100 acres of land, composed principally of Victoria fine sandy loam, and irrigated by water pumped from the Rio Grande by a privately-owned irrigation company. Approximately 80 acres of the Station are used in growing crops, the remaining portion being used for roadways, canals, drains, farmstead, and so forth. All of the waste land on the Station was reclaimed this season.

This Station was establishel to satisfy a rather insistant demand for

the establishment of a research institution to study the problems of the Valley farmers and citrus growers under actual field conditions. The main objective of the Station is to determine the factors affecting the production of crops common to this region or that may be grown in this region and to gather reliable information concerning the production of these crops. The work of this Station may be divided into the following groups: Citrus fruits, horticultural crops, insect pest control, plant introduction, field crop experiments, and root rot research with fruit and vegetable crops.

Citrus Fruit Production: Irrigation was found to be more important than fertilization and probably as important as covercropping in the development of a young bearing grapefruit orchard, under the conditions of this test. Cultivation was not found to be essential to the production of heavy crops of fruit and to the growth and development of the trees. Spring and summer applications of quickly available nitrogenous fertilizer produced the most outstanding results in the fertilizer test. Individual tree differences were found to account for rather marked differences in the yield from different plants. Some trees produced as much as 400 pounds of fruit to the tree, while other trees in the same plat, with apparently identical environmental conditions, produced less than half of that amount. Trees growing in alfalfa sod produced more than twice the amount of fruit produced by clean cultivated trees receiving 15 pounds of 8-4-4 fertilizer. Heavy pruning reduced the yield of fruit approximately 50 pounds to the tree and had little or no effect on the size of the fruit. The difference between the yield from unpruned and lightly pruned trees was negligible.

Root Stock Variety Tests: The three-acre orchard started in 1925 has made fairly satisfactory progress and most of the trees of the early planting are producing fruit this season. The soil in this orchard has been double-cropped during the entire period since the trees were set. The behavior of standard varieties of citrus budded on Calamondin stock is the most outstanding result of this test. Dwarf sorts, such as Kumquat, Satsuma, Meyer lemon, and some round oranges seem to thrive on this stock. Grapefruit and the more rank-growing varieties of oranges show a decided tendency to overgrow on this stock. It apparently imparts some hardiness to limes. Low temperatures which killed King Mandarin trees on sour orange roots did not kill any wood on lime trees on Calamondin roots.

Cabbage Variety Tests: Copenhagen Market and Glory of Enkhuizen were the most desirable varieties in the test this season. Copenhagen market cabbages were much less hardy, but much more uniform and much earlier than either Enkhuizen or Stein's Flat Dutch. Marked differences in the uniformity of the crop grown, from different strains of seed were again noted this season.

Onion Culture Tests: Plats originally intended for thrip-control investigations were used in a study of methods of starting Bermuda onions. Sets produced the earliest and largest onions, but practically all of the onions were splits or doubles. Field seeding as compared with the customary method of transplanting produced earlier and larger onions, though not as uniform a lot.

Beet Variety Test: Much variation was found in the crops grown from a number of commercial strains of Crosby and Detroit Dark Red beets.

Carrot Variety Test: Danvers, a variety that is becoming popular in some truck-growing sections of the Valley, was not found to be as uniform as the average Chantenay carrot, being much coarser and with many side roots. The popularity of the Danvers carrot lies in its greater hardiness and ability to withstand blight.

Tomato Variety Test: Burbank, June Pink, Louisiana Pink, and Gulf States Market were the high-yielding varieties this season. Four strains of Marglobe and two strains of Globe were the lowest-yielding varieties in the test. Burbank plants produced four times as many marketable tomatoes as Marglobe plants from the highest-yielding strains in the test. Puffiness or pockets continued to be the principal factor in tomato production. No varieties were found to be immune to this puffiness, but in the case of the Fargo variety this puffiness was confined to a single plant.

Tomato Spacing Test: Spacing 3x3 feet gave yields three times as great as spacing 6x6 feet, and twice as great as spacing 3x6 feet, when delayed thinning was used in an effort to determine the effect of spacing on the yield of Cooper's Special tomatoes. The average size of tomatoes from the 3x3 plats was 25 per cent less than from the 6x6 or 3x6 plats. There was no significant difference in the time of ripening of the bulk of the crop from the different plats. Wing protection due to the thicker spacing probably accounts for the decided difference in yield and size of the fruit.

Individual Plant Records: Individual plant records were made on a number of plants of several varieties of tomatoes. On some individual plants 80 per cent of the crop showed the condition known as puffiness or pockets, while plants of the same strain immediately adjoining showed no puffiness in the fruit. Marked differences in, showing a lack of uniformity of the fruit produced by different plants, were also noted this season.

Tomato Irrigation Test: Excessive rainfall made it impossible to make a complete study of the effect of varying the amount of water applied on the presence or absence of puffiness. The yield was greater and the percentage of puffy tomatoes lower on those plats receiving the greatest amount of water at the more frequent intervals.

Tomato Fertilizer Test: Applications of 600 pounds of an 8-4-0 fertilizer produced yields slightly higher than applications of the same amount of 8-4-4 or 8-4-8 fertilizers. The use of 600 pounds of an 8-4-0 fertilizer practically doubled the yield of Cooper's Special tomatoes and doubling the quantity of fertilizer practically doubled that yield. The most outstanding result was that the percentage of puffy tomatoes from the plat receiving an 8-4-8 fertilizer at the rate of 1200 pounds to the acre was 80 per cent, while the average of the other plats was below 20 per cent.

Tomato Spraying and Dusting: Spraying and dusting with sulphur or sulphur compounds increased the yield of tomatoes and also the average weight of the fruit.

Variety and Strain Tests of Potatoes: Marked differences were found in the yields from lots of seed certified by the same State and lots certified by different States. Some certified seed did not produce yields as great as some of the uncertified commercial seed. Irish Cobbler potatoes produced yields almost three times as great as Bliss Triumph potatoes in adjoining plats. Yields produced from home-grown seed of the fall crop were very unsatisfactory.

Irrigation Tests with Potatoes: Soil moisture was found to be a very important factor in potato production this season. Yields were in direct proportion to the amount of moisture supplied by irrigation during the month of March under the conditions of this test. Overhead sprinkling was more beneficial than furrow irrigation.

Cotton Variety Tests: Early varieties, such as Delfos and Express, produced the highest yield this season. Most varieties produced an excessive amount of vegetative growth, due to the excessive rainfall in May. Varieties with heavy foliage lost most of their bolls from angular leaf spot disease during the rainy weather in May.

Corn Variety Tests: Yields on all variety plants were lower than normal this season. Oklahoma White Wonder, Tuxpan, and Hastings Prolific were the high-yielding sorts. Because of its hardiness, Tuxpan is the most desirable of the three high-yielding varieties.

Legume Variety Test: Chinese Red cowpeas produced less cured forage to the acre than any of the vining varieties of cowpeas, but were more prolific of pods and much more suitable for hay-making than the vining sorts. Mung beans produced a yield of forage comparable to Brabham or Iron cowpeas and were somewhat less affected by root rot than any of the legumes in the test.

Corn-Grain Sorghum Adaptability Test: Darso was the only variety of grain sorghum that produced a yield of grain in any way comparable with the yield of Tuxpan corn. The bird damage to the heads was almost 100 per cent in the case of some plats of kafir, milo, and hegari,

but was practically negligible on the Darso plats. Where yield of forage is considered, Darso is a most promising forage crop for this section.

Cotton Spacing Test: Four-inch spacing gave the highest yield of cotton this season where soil moisture was not a limiting factor. Fourteen- and 18-inch spacing gave the highest yields on plats not receiving an application of irrigation water during the month of April.

Plant Introduction and Adaptability Tests: A number of both ornamental and crop plants not commonly grown in this region have been assembled on the Station and are being studied to determine their adaptability. Many plants are extremely chlorotic when grown in the soil of this region, which is probably due to the excessive amount of lime in the soil. Applications of iron sulphate have brought about rather marked changes in the appearance of some of these chlorotic plants. Among the more important plants that have been found to be useful for this region are Athel, Algerian Pepper, Bauhinia, Cotoneaster pannosa, Meyer Lemon, Clemantine Orange, Rusk Citrange, Champanel Grape, Black Spanish Grape, a native hybrid grape; Para Grass, Angleton Grass, Darso, Jujubes, and Dates. Also, a large number of varieties of grapes, figs, pecans, berries, and many ornamental plants are being studied to determine their adaptability. Wind and soil moisture were found to be the most important factors affecting the development of hardy (Mexican) avocado trees in this region. The practicability of rooting large offshoots of the commercial date palm that have been heat-treated to free them of insect pests and transported a considerable distance has again been demonstrated this season.

Control of Mildew on Cucumbers: Sulphur and sulphur compounds were more effective than copper compounds in controlling mildew on cucumbers. Sulphur produced much less injury on cucumber foliage than on cantaloupe foliage.

Seed Treatment to Control Potato Scab: Insufficient scab developed in the crop grown from one lot of certified seed to make comparisons of the results. In one lot of potatoes grown from scabby seed the results were decidedly in favor of seed treatment. Soaking the seed pieces in a solution of acid phosphate apparently increased the yield of marketable potatoes.

Bark Disease Control in Aged Pomelo Orchard: About one hundred trees were treated for gummosis and scaly bark by the scraping and painting method. The surgical treatment was found to be more impotrant in treating the disease than the antiseptic treatment given after the paring and scraping. Heavy pruning and defruiting of badly infected trees was found to be beneficial. A mixture of resin, alcohol, and bichloride of mercury was as effective as any wound covering used.

Control of Scale Insects on Citrus: California Red Scale continues to be the major insect pest of citrus in the Lower Rio Grande Valley, and

is rapidly becoming more prevalent throughout the whole fruit-growing section. Fumigation experiments were repeated in the winter, using calcium cyanide dust. From the standpoint of scale mortality, fumigation is satisfactory but reinfestation occurring in latter July and August caused much damage to the fruit before picking time.

Cotton Root Rot Research: Research work on the cotton root rot disease as affecting fruit and truck crops in the Lower Rio Grande Valley was started in May, 1927. A method of artificially producing the disease by the use of freshly infected cotton roots was found satisfactory (July 8, 1927) for infection studies and to facilitate resistance tests. One root showing an abundance of mycelium, when placed in contact with the tap root, was sufficient to produce infection. Macerated roots caused no infection. Some infection resulted when the inoculum was placed as far as 20 inches from the plant. Roots from plants that had wilted three weeks previously produced very little infection, while older roots produced none.

Positive artificial infection of woody plants was secured for the first time when four young olive trees were inoculated on September 3, 1927. Artificial infection has since been secured on woody plants with cotton on peach and prune and with carrot on pear, apple, grape, fig, Marianna plum, Chinese Elm, and American White Elm. Other successful cross inoculations have been made with carrots on sugar beets, sunflower, seven varieties of cowpeas; and with grape, sweet potato, sugar beet, and American White Elm on cotton. No infection occurred in about one thousand attempts on fibrous rooted plants, such as corn and grain sorghums. Spores failed to produce infestation.

A check of variety and spacing for two seasons shows that root rot occurs in spots regardless of variety or spacing. This check, as well as general observations, shows the appearance of root rot to be closely correlated with the weather. Moisture and temperature are also important factors in the occurrence of spore spots.

Observations on a large number of cotton plants indicates that the plants are killed by having their tap root girdled by the fungus. In many cases the tips of the tap root and a number of the laterals remain alive.

Sulphur, manure, superphosphate, and muriate of potash failed to control root rot or prevent spread by changing the pH of the soil. Winter spread advanced from three to ten feet during a period of seven months. The application of chemicals, including copper sulphate, formaldehyde, semesan, phenol, and mercuric bichloride, has been tried in an attempt to arrest the spread. Likewise, the application of copper sulphate, semesan, lime sulphur, copper carbonate, copper lime dust, sulphur, iron sulphate, monohydrated copper sulphate, and salt in the hopper at the time of sowing cotton is being tried.

A rotation experiment has been started in which eight different four-year rotations adaptable to Valley conditions are being tested in

an effort to reduce the loss from root rot. This rotation includes cabbage, cotton, sorghum, peas, carrots, corn, tomatoes, and clean culture.

Sixty varieties of grapes, twelve of the most promising root stocks and a number of grafted vines, have been planted in an effort to discover some resistant rootstock. The Mustang, Black Spanish, Champanel, 3306 Hybrid and V. Champini show some resistance. Other fruit and shade trees and ornamentals have been planted in order to test their resistance to the root rot disease.

Substation No. 16, Iowa Park

Substation No. 16 is located ten miles west of Wichita Falls, and two miles southeast of Iowa Park, Wichita County, on the Fort Worth and Denver City Railway, in the heart of the Wichita Valley Irrigation Project; latitude 33 degrees and 55 minutes north, and longitude 98 degrees and 39 minutes west. The average annual rainfall over a period of eleven years is 26.86 inches. The Station comprises 161.79 acres of land. The soils are chiefly of the Yahola and Miller series, which are typical alluvial soils found along streams flowing through the Permian Redbeds of North Texas.

This Station was established in 1924, and is conducting investigations which are intended to assist in directing the farming operations in the Wichita Valley along the proper lines. The proper methods and best means of applying irrigation water to the Valley lands are important phases of the work of this Station, to the end that the best use of water might be advocated for the farms in this section.

Until the last ten years small grains were practically the only crops grown in this section, but cotton and grain sorghums are now being grown extensively. These three crops are grown on approximately 95 per cent of the tillable area of Wichita County and are very important in the irrigated area also. The most important lines of work conducted on the Station thus far have been the testing out of many varieties of field and garden crops and the growing of fruit and ornamental plants and trees to test their adaptability and value to the section. An important problem which is receiving careful attention is the cotton root rot disease, and intensive work is being done looking toward a means of controlling this disease.

Cotton Under Irrigation: Twenty varieties of cotton were tested on this Station under irrigation during 1927. Durango X Half and Half made the highest yield, 488.19 pounds of lint to the acre. It was followed by Delfos T. S. No. 9600 and Alaca T. S. No. 11,607, which yielded 433.1 and 425.05 pounds of lint to the acre, respectively. Boll-weevil damage was serious, which lowered the yield of the different varieties accordingly. Experiments were conducted with different kinds of fertilizers for cotton, as well as spacing tests, but the results to date are not conclusive.

Feed and Forage Crops: The variety test of grain sorghums was planted rather late this year, which rendered the results somewhat less accurate than for the normal time of planting. Schrock kafir yielded at the rate of 23.29 bushels to the acre, in comparison with 19.29 bushels of Blackhul kafir 153. Hegari made a poor third in rank for this test, and no yield resulted with Dwarf milo because of chinch bugs. Chiltex, which ordinarily is a good producer in this region, failed to germinate on account of fire-damaged seed; and Spur feterita made practically no crop because of depredation by birds. Blackhul kafir 153 in the seed increase block, planted June 4, again demonstrated its value for this region by producing at the rate of 44.57 bushels of grain and 5.58 tons of cured stover to the acre. On account of severe root-rot damage to alfalfa not much of this crop remains on the Station; however, one small field made two fair cuttings before root-rot damage occurred in midsummer. Alfalfa sowings in the spring of this year have given scanty yields, which indicates that fall planting is best, because of freedom from weeds, resulting in increased production the first season. Midsummer plantings of Proso (hog millet) resulted in poor germination and very short growth, although a creditable showing was made with spring sowing in 1928.

Kanota Oats: Due to a severe freeze extending from December 30 to January 5, during which the temperature dropped as low as 8 degrees Fahrenheit, all of the winter oats were frozen out. Only one small plat of Kanota oats survived the winter and this was due to germination of the seed after the freeze. Some of the seed germinated in the early spring and all of the crop stooled out well. The harvest resulted in a yield at the rate of 33.74 bushels to the acre. Oats sown in February for feed yielded approximately 34 bushels to the acre.

Rice: Three varieties of rice were tested under irrigation on this Station in 1927. While no yields were recorded, the maturing of Early Prolific and Blue Rose near the middle of October with a fair crop indicates that this crop might be adapted to this region.

Tobacco: An experiment in cooperation with the Tobacco By-Products and Chemical Corporation, Louisville, Kentucky, was conducted with tobacco (*N. tomaccum* and *N. rustica*) having a high content of nicotine. The object of the experiment is to determine the feasibility of producing a high nicotine tobacco suitable for use as an insecticide. So far the work is not conclusive, but the indications are that the tobacco grown is not well suited to the soil and climatic conditions of the region.

Orchard: An orchard of approximately five hundred trees was started in the spring of 1926 and additions have been made each year, the latter plantings being chiefly peaches. Due to spring freezing, the buds of the peach trees, which constitute the major part of the orchard, were killed and no fruit was produced. Flooding of part of the orchard during freezing failed to prevent damage. A few trees among the plums of bearing age bore fruit, these being the Compass and Sapa, both of which

are hybrids and are recommended as among the surest to fruit in this region. Many of the apple trees have been killed by the root-rot disease and several trees were damaged or killed from rabbit injury. The Jujube orchard, consisting of four varieties, which was set out in 1925, has been setting fruit for the past three years, all varieties bearing heavily this year.

The grape vineyard, consisting of 25 varieties, bore a small amount of fruit this year, and should have produced well, but late freezing prevented the production of a large crop. Many of the vines have been killed out or infected seriously with root rot, which has tended to discourage the growing of grapes here, at least on the heavy soils. Two attempts to grow currants have met with failure, as they appear to be unable to withstand the heat of midsummer.

Truck and Garden Crops: Eight varieties of cantaloupes were tested this year, which produced an excellent crop of well flavored melons. Due in part to a retarded season, the melons were slightly late this year, as compared to the usual harvest during the latter part of July. Hale's Best, Burrell's Improved, Rocky Ford, Anne Arundel, and Superfecto made yields of 295.6, 265.8, 254.1, 207.4, and 206.2 crates of 12 melons each, respectively. Cabbage was grown again this year with fair success, although the land is not exactly suitable for this crop. Irish potatoes under treatments of thirteen different combinations of commercial fertilizers, manure, and straw were tested this year, being grown on medium loam soil. The crop was considerably damaged by freezing of the tops. Asparagus, a new crop for this section, has been tested the past two years with gratifying success, as it produces well and has shown no loss from disease or insect damage. Rhubarb and horseradish both died from root rot. Spinach was frozen out during the winter, but the fall planted spinach produced satisfactorily. Tomatoes failed to set fruit, as usual, during the hot part of the summer and commenced setting fruit in August, so that over a short period in Autumn there was a fair crop of ripe fruits.

Cotton Root Rot Studies: Several methods for the control of root rot have been tried at this Station, without conclusive results. The addition of manure and inorganic fertilizers, including sulphur, was undertaken in an attempt to change the soil reaction to such an extent that it would be unfavorable to the fungus. This experiment has been carried out on two types of soil—the Miller loam and the Yahola very fine sand. Rotation as a means of control was carried on in 1927 with cotton, guar, hegari, Sudan grass, and Sesbania. In 1928 these crops were followed with cotton to determine the effect of the previous crop on the amount of root rot in cotton. Flooding the land promised to be a means of control, but before the summer was over the cotton on all of the plats which had been flooded developed root rot. Fall inoculations showed that it was possible to obtain infections at that time of the year. Studies of the susceptibility of nursery stock to root rot were made during the year,

using 1176 plants, representing 105 varieties. As soon as the plants started to grow vigorously, they were inoculated with the root-rot organism. Fifty-two varieties or strains of alfalfa were planted and inoculated with the root-rot organism to ascertain the susceptibility of the different varieties or strains to the root-rot disease. Two spore spots developed during the year on each of two fields of alfalfa, which offered a good opportunity to study the formation of spores and spore spots. None of the second crop of spore spots seemed to be the reappearance of those of the first crop.

CO-OPERATION

In accordance with the long-established policy of the Texas Station to cooperate whenever cooperation may be mutually desirable, formal agreements providing for cooperative research have been entered into or continued during the year, as follows:

1. Bureau of Plant Industry, Office of Forage Crops, United States Department of Agriculture, in the operation of Substation No. 12, Chillicothe, Texas, and in general forage crops work throughout the State.
2. Bureau of Plant Industry, Office of Foreign Seed and Plant Introduction, United States Department of Agriculture, for the introduction, propagation, and distribution of newly introduced plants which give promise of becoming valuable in Texas.
3. Bureau of Plant Industry, Office of Cotton and Truck Diseases and Sugar-Plant Investigations, United States Department of Agriculture, for annual plant disease survey in Texas and for a general study of plant diseases.
4. Bureau of Plant Industry, Office of Crop Physiology and Breeding, Date Investigations, in testing of dates at Substation No. 15, Weslaco, Texas, and in Southwest Texas.
5. Bureau of Chemistry and Soils, Division of Soil Survey, United States Department of Agriculture, for the conduct of soil survey work in Texas.
6. Bureau of Chemistry and Soils and Bureau of Plant Industry, United States Department of Agriculture, and the University of Texas, for soil and crop studies in Texas in connection with investigations of root rot of cotton.
7. Bureau of Entomology, United States Department of Agriculture, for cooperative investigations of insects and parasites affecting livestock.
8. Bureau of Entomology, United States Department of Agriculture, for cooperative investigations of the biology and control of the pink bollworm of cotton.
9. Bureau of Animal Industry, United States Department of Agriculture, for investigations as to the adaptability of the Corriedale sheep to Texas conditions, the study of soft pork investigations, and cattle feeding and killing qualities.
10. Bureau of Agricultural Economics, United States Department of Agriculture, for an economic study of the agriculture of the Elephant Butte irrigation project.
11. Bureau of Agricultural Economics, United States Department of Agriculture, for studies of farmers' and ranchmen's business organizations and in studies of local cotton marketing.
12. Bureau of Agricultural Economics, United States Department of Agriculture, for study of the effect of variations in the ginning processes on the physical properties of upland cotton.

13. Bureau of Biological Survey, United States Department of Agriculture, and the Extension Service of the Agricultural and Mechanical College of Texas for rodent control work in Texas.
14. Food, Drug, and Insecticide Administration, United States Department of Agriculture, for inspection of feeding stuffs.
15. Freeport Sulphur Company, Freeport, Texas, in furnishing funds and materials for the study of sulphur as a fertilizer, as an insecticide, and as a fungicide.
16. The Barrett Company of Texas, for fertilizer work with rice by furnishing fertilizer materials.
17. The Chilean Nitrate of Soda Educational Bureau, in furnishing funds for the establishment of a fellowship for the study of the effect of Chilean Nitrate of Soda applications to soils.
18. School of Agriculture, Agricultural and Mechanical College of Texas, wherein Station men may give lectures to students and teachers may do cooperative investigation work for the Station.
19. School of Veterinary Medicine, Agricultural and Mechanical College of Texas, whereby the Dean of the School of Veterinary Medicine acts as Chief of the Division of Veterinary Science for the Station.
20. School of Engineering, Agricultural and Mechanical College of Texas, wherein certain professors may cooperate with Station workers in agricultural studies involving engineering problems.
21. Extension Service, Agricultural and Mechanical College of Texas, wherein Extension Service workers from time to time suggest the more important problems confronting Texas farmers and stockmen and certain Extension specialists cooperate with the Station in making certain investigations mutually agreed upon.
22. Denton County Pure Seed Association, for the increase and distribution of outstanding strains of small grain, particularly Denton wheat and Nortex oats.
23. The State Livestock Sanitary Commission, in studies of the sheep scab mite at the Ranch Experiment Station (Substation No. 14), Sonora.
24. Western Weighing and Inspection Bureau, wherein the railroads of the State and Southwest furnish a fund for the conduct of research and investigations of the various transit and storage diseases affecting fruits, vegetables, and other field crops.
25. The Texas Cottonseed Crushers Association, in furnishing cottonseed feeds in connection with utilization studies with cottonseed products.
26. The King Ranch, in cattle feeding studies in which the King Ranch, Kingsville, Texas, has furnished cattle, feeds, and labor used in feeding work studies by this Station and the Bureau of Animal Industry.

FINANCIAL STATEMENT

Texas Agricultural Experiment Station

College Station, Texas,
October 15, 1928.

Director A. B. Conner, Texas Agricultural Experiment Station System.

Dear Sir: I do hereby certify that to the best of my knowledge and belief the following report upon the receipts and disbursements of the several funds devoted to the development, maintenance and support of the Texas Agricultural Experiment Station System correctly reflects the official accounts for the fiscal year ending August 31, 1928.

(Signed) M. P. Holleman, Jr.,
Chief Clerk (Bonded).

Subscribed and sworn to before me, J. M. Schaedel, Notary Public in and for Brazos County, Texas, on the 15th day of October, A. D. 1928.

(Signed) J. M. Schaedel,
Notary Public in and for Brazos County, Texas.

FUNDS AVAILABLE

	Amount
Total	$ 748,439.53
Hatch Fund, from United States Treasurer for the year ending June 30, 1928	$ 15,000.00
Adams Fund, from United States Treasurer for the year ending June 30, 1928	15,000.00
Purnell Fund, from United States Treasurer for the year ending June 30, 1928	40,000.00
Main Station, from State Treasurer for the year ending August 31, 1928	230,694.70
Main Station, from State Treasurer (unexpended balance from the year ending August 31, 1927)	19,120 85
Substations, from State Treasurer for the year ending August 31, 1928	125,788.03
Substations, from State Treasurer (unexpended balance from the year ending August 31, 1927)	8,074.38
Main Station Treasury, from sale of products for the year ending August 31, 1928, including balance brought forward	53,265.68
Substation Treasury, from sale of products for the year ending August 31, 1928, including balance brought forward	118,807.72
Feed Control Service, from sale of tags for year ending August 31, 1928	122,688.17

CLASSIFICATION OF EXPENDITURES

Total		$ 718,439.53
Salaries	$ 273,501.54	
Labor	82,551.37	
Stationery and office supplies	5,735.03	
Scientific supplies (consumable)	10,274.05	
Feeding stuffs	22,185.25	
Sundry supplies	22,399.48	
Fertilizers	760.24	
Communication service	4,732.95	
Travel	36,940.53	
Transportation of things	3,847.13	
Publications	10,912.45	
Heat, light, water and power	9,001.87	
Furniture and fixtures (office equipment)	7,583.22	
Library	1,290.00	
Scientific equipment	11,598.14	
Live stock	2,296.13	
Tools, machinery and appliances	18,028.61	
Buildings and land	67,742.43	
Contingent expenses	5,960.10	
Transfers	11,129.28	
Chemical analyses and tag refunds	13,121.50	
Feed control surplus remitted to Treasurer of College	58,394.41	
Reverted to State Treasury (1926-27 unexpended balance)	8,788.32	
Unexpended balance (as of August 31, 1928)	59,665.50	

ANALYSIS OF UNEXPENDED BALANCE AS OF AUGUST 31, 1928

Total		$ 59,665.50
Main Station Appropriation	$ 13,618.23	
Substation Appropriation	4,946.63	
Main Station Sales Fund	16,888.71	
Substation Sales Fund	24,211.93	

FEDERAL FUNDS

Total	$ 70,000.00

Hatch Fund

Items	Debit	Credit
Total	$ 15,000.00	$ 15,000.00
Received from Treasurer of the United States	$ 15,000.00	
Salaries		$ 11,547.50
Labor		135.00
Stationery and office supplies		19.00
Communication service		101.00
Live stock		168.00
Buildings and lands		29.50

Adams Fund

Items	Debit	Credit
Total	$ 15,000.00	$ 15,000.00
Received from Treasurer of the United States	$ 15,000.00	
Salaries		$ 13,208.34
Labor		766.71
Scientific supplies (consumable)		678.68
Feeding stuffs		20.00
Sundry supplies		133.22
Communication service		.01
Transportation of things		56.23
Heat, light, water and power		37.26
Furniture and fixtures (office equipment)		10.00
Library		8.85
Scientific equipment		49.90
Live stock		5.50
Tools, machinery and appliances		25.30

Purnell Fund

Items	Debit	Credit
Total	$ 40,000.00	$ 40,000.00
Received from Treasurer of the United States	$ 40,000.00	
Salaries		$ 19,351.67
Labor		8,950.36
Stationery and office supplies		601.97
Scientific supplies (consumable)		2,638.99
Feeding stuffs		573.25
Sundry supplies		339.72
Communication service		101.36
Travel		1,629.89
Transportation of things		230.30
Furniture and fixtures (office equipment)		886.09
Library		83.00
Scientific equipment		3,587.17
Live stock		87.50
Tools, machinery and appliances		20.98
Buildings and lands		917.75

STATE APPROPRIATIONS

Main Station

Division	Debit	Credit
Total	$ 230,694.70	$ 230,694.70
Received from the State Treasurer	$ 230,694.70	
Salaries		$ 53,762.50
Administrative		9,166.59
Veterinary Science		6,969.21
Horticulture		4,151.03
Range Animal Husbandry		6,481.18
Entomology		2,482.15
Foul Brood		9,029.48
Rodent Control		6,952.20
Apiculture		8,198.20
Agronomy		4,874.77
Main Station Farm		6,609.64
Plant Pathology and Physiology		2,027.07
Soil Survey		8,904.97
Farm and Ranch Economics		6,150.00
Publications		8,000.00
Botany		399.87
Reserve		1,997.33
Cotton Root Rot Investigations		47,912.19
Cotton Insect Investigations		23,008.09
Balance unexpended (vouchers pending)		13,618.23

Main Station

Division	Debit	Credit
Total	$ 19,120.85	$ 19,120.85
Received from the State Treasurer (unexpended balance from 1926-27 appropriation)	$ 19,120.85	
Salaries		
Administrative		$ 612.58
Veterinary Science		29.95
Horticulture		319.61
Range Animal Husbandry		162.79
Entomology		163.18
Foul Brood		16.83
Agronomy		397.75
Plant Pathology and Physiology		12.07
Farm and Ranch Economics		21.69
Botany		5.55
Publications		693.21
Apiculture		32.50
Main Station Farm		18.51
Reserve		1,096.39
Cotton Insect Investigations		2,794.27
Cotton Root Rot Investigations		4,073.89
Reverted to State Treasury		8,670.08

STATE APPROPRIATIONS—Continued

Substations

Stations	Debit	Credit
Total	$ 125,788.03	$ 125,788.03
Received from the State Treasurer	$ 125,788.03	
No. 1. Beeville		$ 6,520.26
2. Troup		5,249.71
3. Angleton		5,145.74
Angleton (special)		2,904.71
4. Beaumont		5,272.38
5. Temple		6,000.00
6. Denton		6,700.00
7. Spur		6,340.58
8. Lubbock		7,005.91
9. Balmorhea		4,810.16
10. Feeding and Breeding Station, College Station		9,455.92
Dairy section		2,540.05
Swine section		2,940.87
Poultry section		2,291.39
11. Nacogdoches		4,698.23
Nacogdoches (special)		602.55
12. Chillicothe		4,761.19
14. Sonora		11,995.04
15. Weslaco		13,707.03
16. Iowa Park		7,181.68
Denton (deficiency)		4,718.00
Balance unexpended (vouchers pending)		4,946.63

Substations

Stations	Debit	Credit
Total	$ 8,074.38	$ 8,074.38
Received from the State Treasurer (unexpended balance from 1926-27 appropriation)	$ 8,071.38	
No. 1. Beeville		$ 216.02
2. Troup		160.78
3. Angleton		
4. Beaumont		257.08
5. Temple		253.52
6. Denton		.53
7. Spur		
8. Lubbock		99.95
9. Balmorhea		
10. Feeding and Breeding Station, College Station		
Dairy section		
Poultry section		340.12
Swine section		501.25
11. Nacogdoches		87.67
12. Chillicothe		9.30
14. Sonora		57.64
15. Weslaco		289.88
16. Iowa Park		4,182.40
Iowa Park (emergency)		1,500.00
Reverted to State Treasury		118.24

SALES FUNDS

Main Station Treasury

Divisions	Debit	Credit
Total	$ 53,265.68	$ 53,265.68
Balance brought forward from previous year	$ 15,346.91	
Received from sales during year	37,918.77	
Administrative		$ 411.51
Soil Survey		2,895.21
Range Animal Husbandry		4,407.34
Main Station Farm		4,142.45
Agronomy		6.00
Entomology		43.09
Entomology Certificate Fund		50.00
Horticulture		151.06
Apiculture		357.31
Veterinary Science		1,506.44
Plant Pathology and Physiology		3,176.13
Chemistry (Analysis Fund)		11,905.89
Sulphur Fund		2,249.02
Farm and Ranch Economics		547.36
Photographic Laboratory		1,366.62
Interest and Discount		1,170.75
Main Station Auto Fund		265.88
Publications		60.06
Farm Bureau Fund		
Nitrate Fellowship Fund		1,369.35
Rodent Poison Fund		295.50
Balance		16,888.71

Substation Treasury

Station	Debit	Credit
Total	$ 118,807.72	$ 118,807.72
Balance brought forward from previous year	$ 20,962.66	
Received from sales during year	97,845.06	
No. 1. Beeville		$ 1,369.46
2. Troup		774.48
3. Angleton		1,290.19
4. Beaumont		821.46
5. Temple		609.31
6. Denton		3,346.45
7. Spur		5,893.92
8. Lubbock		2,171.86
9. Balmorhea		2,326.37
10. Feeding and Breeding Station, College Station		3,868.03
Dairy section		10,933.67
Poultry section		5,851.06
Swine section		7,727.66
11. Nacogdoches		335.08
12. Chillicothe		2,842.81
14. Sonora		10,036.99
15. Weslaco		7,238.30
16. Iowa Park		954.68
Ten Per Cent Fund		10,168.30
Tobacco By Products Fund		
Cottonseed Products Equipment Fund		500.00
Temple (special)		15,535.71
Balance		24,211.93

FEED CONTROL SERVICE

Item	Debit	Credit
Total	$ 122,688.17	$ 122,688.17
Receipts		
Tax collected (inspection tax tags)	$ 122,688.17	
Disbursements		
Salaries		$ 26,830.00
Labor		617.16
Stationery and office supplies		915.27
Sundry supplies		10,822.69
Communication service		866.88
Travel		9,357.26
Transportation of things		5.26
Publications		1,231.23
Heat, light, water and power		.35
Furniture and fixtures (office equipment)		388.76
Library		7.50
Tools, machinery and appliances		7.20
Contingent expenses		122.70
Chemical analyses		13,000.00
Refund on tags redeemed		121.50
Net surplus		58,394.41

INVENTORY VALUATION

Grand total valuation of properties used by Agricultural Experiment Station System		$1,268,820.02
Owned by Station System and carried on Station Inventory	$1,099,370.33	
Owned by College proper and carried on College Inventory, but used by Station System for Station purposes	169,449.69	

Station System Property

Total inventory valuation		$1,099,370.33
Main Station	$ 287,111.81	
Substations	812,258.52	

Main Station

Total inventory valuation		$ 287,111.81
Administrative	$ 41,053.28	
Veterinary Science	33,119.88	
Chemistry	18,683.61	
Range Animal Husbandry	21,068.64	
Farm and Ranch Economics	3,338.49	
Agronomy	10,850.68	
Photographic Laboratory	2,789.66	
Botany	2,235.19	
Entomology	14,135.32	
Plant Pathology and Physiology	8,765.38	
Apiculture	21,397.40	
Soil Survey	1,508.30	
Horticulture	21,803.77	
Main Station Farm	35,762.94	
Rural Home Research	7,193.24	
Publications	39,388.50	
Feed Control Service	3,417.53	

Substations

Total inventory valuation			$ 812,258.52
No. 1.	Beeville	$ 26,575.63	
2.	Troup	35,865.00	
3.	Angleton	21,116.27	
4.	Beaumont	36,078.10	
5.	Temple	48,214.28	
6.	Denton	39,283.10	
7.	Spur	64,335.98	
8.	Lubbock	37,494.41	
9.	Balmorhea	30,722.60	
10.	Feeding and Breeding Station, College Station	62,625.50	
	Dairy section	22,205.90	
	Poultry section	11,939.15	
	Swine scetion	13,500.15	
11.	Nacogdoches	25,607.54	
12.	Chillicothe	29,600.10	
14.	Sonora	144,653.59	
15.	Weslaco	118,785.57	
16.	Iowa Park	43,655.65	

SOIL REGIONS OF TEXAS: PRINCIPAL SURFACE FEATURES, SOIL SERIES, AND CROPS.

Humid Region

(30 inches or more average annual rainfall)

1. Gulf Coast Prairie: Flat, heavy growth of coarse grasses; heavy dark soils, some sandy light colored soils. Soil series; Lake Charles, Edna, Katy, Hockley, Acadia, Harris. Rice, cotton, corn, figs, truck crops, cattle.

2a, 2b, 2c, 2d. East Texas Timber Country; Timbered sandy soils with clay subsoils.

2a. Northeastern division: Rolling to hilly; pine and some hardwood timber. Principal soil series: Kirvin, Bowie, Norfolk, Ruston, Susquehanna, Caddo, Ochlockonee, Leaf, Myatt, Kalmia, Bibb. Cotton, corn, lumber, truck crops, fruits, livestock.

2b. Western division: Undulating to rolling; timbered with oak mainly. Principal soil series: Kirvin, Susquehanna, Lufkin, Tabor, Crockett, Ochlockonee. Cotton, corn, truck crops, fruits, livestock.

2c. Southeastern: Flat to rolling; longleaf, shortleaf, and loblolly pine. Principal soil series: Bowie, Lufkin, Susquehanna, Caddo, Bibb. Lumber, cotton, livestock.

2d. Central division: Rolling to hilly; pine and some hardwood timber. Soil series same as 2a except that Nacogdoches series—"East Texas Redlands"—are confined mainly to this area. Cotton, corn, truck crops, fruits, livestock.

3. East Texas Cross Timbers: Rolling; sandy soils; oak timber. Soil series: Kirvin, Tabor, Ochlockonee. Cotton, corn, truck crops, fruits.

4. Blackland Prairie: Rolling; grassland; dark, heavy soils. Soil series: Houston, Wilson, Crockett, Ellis, Bell, Irving, Trinity, Catalpa. Cotton, corn, small grain.

5. Blackland interior prairies: Rolling; grassland; dark, heavy soils. Soil series: Wilson, Houston, Crockett. Cotton, corn, livestock.

6. Grand Prairie: Rolling to hilly; grassland; dark, heavy soils that are shallow in many places. Stony and rough areas in southern part. Soil series: Denton, San Saba, Crawford, Trinity, Catalpa, Rough stony land. Cotton, small grain, livestock.

7. Central Basin: Rolling valleys, hills and rough lands; sandy and stony soils, some small oak timber and some small mesquite timber. Soil series: Pontotoc, Lancaster, Tishomingo, Harley, Pedernales. Rough stony land. Range livestock, cotton, small grain.

8. West Cross Timbers and interior prairies: Rolling to hilly; timbered with small oaks in places, small mesquite trees in places and some prairies; sandy and heavy soils. Soil series: Windthorst, Nimrod, Denton. Small grain, cotton, range livestock, truck crops.

Subhumid Region

(15 to 30 inches average annual rainfall)

9. Gulf Coast Plain: Flat to undulating; grassland and abundant small trees (mainly mesquite) and shrubs in places, dark and light colored soils. Soil series: Victoria, Hidalgo, Willacy, Nueces, Laredo, Harlingen, Lomalto, Rio Grande. Cotton, range livestock, citrus fruits, truck crops.

10. Interior Blackland Plains: Flat to undulating; grassland and much shrub and small tree growth, largely mesquite; dark, heavy and sandy soils. Soil series: Goliad, Zapata, and others. Cotton, range livestock.

11. Rio Grande Plain: Undulating to rolling; small trees and shrubs in scattering growth over grassland; mostly sandy soils, though some heavy soils. Soil series: Duval, Webb, Brennan, Maverick, San Antonio, Uvalde, Frio. Range livestock, cotton, truck crops.

12. Edwards Plateau: Rolling and hilly; small oak and mesquite trees and shrubs in scattered growth over grassland; soils mostly dark, heavy, very shallow and stony. Soil series: Rough stony land, Valera, Reagan. Range livestock, sheep, cattle, goats.
13. Northwest Texas Rolling Plains: Undulating to rolling; grassland; brown and reddish sandy and clay loam soils. Soil series: Abilene, Miles, Roscoe, Spur, Rough broken land on western margin. Cotton, grain sorghums, range cattle, small grain.
14. Northwest Texas Redland Plains: Undulating to rolling; some rough, eroded areas; grassland; mostly red sandy and clay loam soils, though some dark soils. Soil series: Vernon, Fowlkes, Wichita, Calumet, Foard, Enterprise, Miller, Yahola, Rough broken land. Range cattle, cotton, small grain, grain sorghums.

15a, 15b. High Plains (Llano Estacado): High flat to undulating; grassland. Soils brown and reddish sandy and clay loams. Soil series: Amarillo, Richfield.

15a. North Plains Division: Soils mostly clay loams. Small grain, grain sorghums, range cattle.

15b. South Plains Division: Soils mostly sandy and of Amarillo series. Cotton, grain sorghums, range cattle.

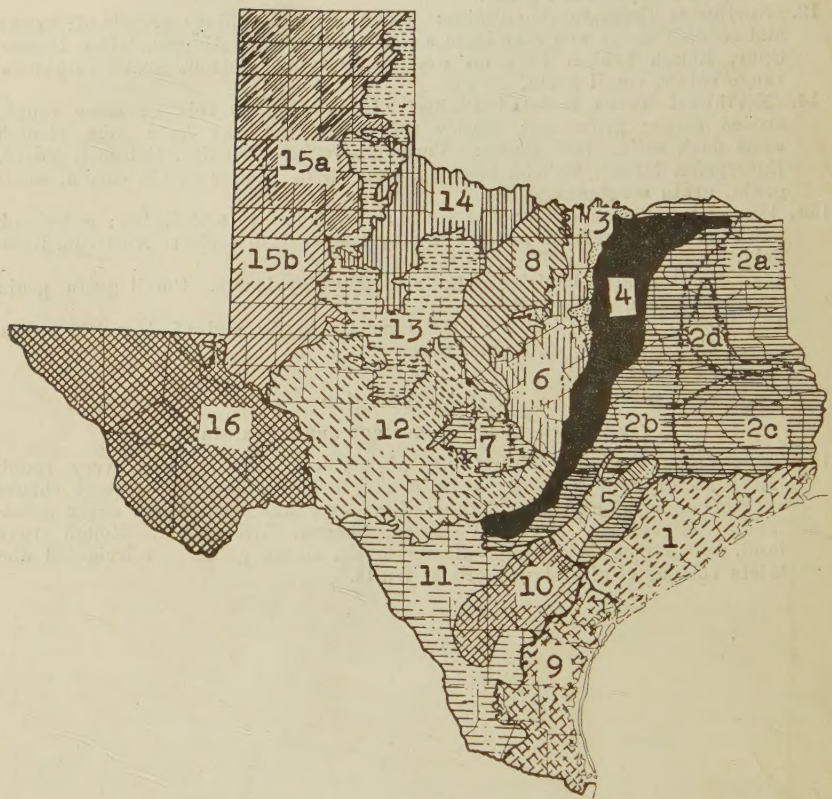
Semiarid Region

(Less than 15 inches average annual rainfall)

16. Trans-Pecos Region: Mountains, plains, and basins; much very rough land; no dryland farming; soils mostly brown and gray. Desert shrubs vegetation in places; considerable thin cover and some thick cover grassland. Soil series: Reeves, Verhalen, Reagen, Toyah, Gila. Rough stony land, rough mountain land. Range cattle, sheep, goats. In irrigated districts cotton, alfalfa, truck crops, fruits.

SOIL REGIONS OF TEXAS

(Prepared by W. T. Carter)



Humid Region

1. Gulf Coast Prairie.
2a, 2b, 2c, 2d. East Texas Timber Country:
   - 2a. Northeastern division,
   - 2b. Western division,
   - 2c. Southeastern division,
   - 2d. Central division.
3. East Cross Timbers.
4. Blackland Prairie.
5. Blackland Interior Prairies.
6. Grand Prairie.
7. Central Basin.
8. West Cross Timbers and Interior Prairies.

Subhumid Region

9. Gulf Coast Plain.
10. Interior Blackland Plains.
11. Rio Grande Plain.
12. Edwards Plateau.
13. Northeast Texas Rolling Plains.
14. Northeast Texas Redland Plains.
15a, 15b. High Plains (Llano Estacado):
   - 15a. North Plains division,
   - 15b. South Plains division.

Semiarid Region

16. Trans-Pecos Region.

(For more detailed information concerning soil regions, see inside cover page)